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	Project Operations HYDROELECTRIC POWER OPERATIONS AND MAINTENANCE GUIDANCE AND PRODCEDURES	
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Project Operations
HYDROELECTRIC POWER OPERATIONS AND MAINTENANCE
GUIDANCE AND PROCEDURES

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CHAPTER 1 - INTRODUCTION

1-1. Purpose. This pamphlet establishes the guidance for the operation and maintenance (O&M) of USACE hydroelectric power generation facilities and related structures at civil works water resource projects and supplements Engineer Regulation (ER) 1130-2-510.

1-2. Applicability. This guidance applies to all USACE commands having responsibility for civil works functions and hydroelectric power generation.

1-3. References.

a. PL 85-507, The Government Employees Training Act, 7 July 1958.

b. PL 95-91, Section 302, 95th Congress, Department of Energy Organization Act, 4 August 1977 (91 Stat. 565).

c. PL 99-662, Section 937, Reports on Hydropower Statistics, Water Resources Development Act of 1986.

d. PL 104-303, Section 216, Water Resources Development Act of 1996.

e. PL 534, Section 5, 78th Congress, Flood Control Act of 1944, 22 December 1944, (58 Stat. 889).

d. AR 690-400, Employee Performance and Utilization, Chapters 410, 430 and 432.

e. USACE Supplement 1 to AR 690-400, 410 and 430, Employment Performance and Utilization Training.

f. ER 385-1-31, Safety Clearance Procedures

g. ER 1105-2-100, Guidance for Conducting Civil Works Planning Studies.

h. ER 1110-2-109, Hydroelectric Design Center.

i. ER 1110-2-1200, Plans and Specifications.

j. ER 1130-2-500, Partners in Support (Work Management Policies).

k. ER 1130-2-510, Hydroelectric Power Operations and Maintenance Policies.

l. REMR Condition Rating Procedures/Condition Indicator For Hydropower Equipment.

1-4. Glossary.

a. Allocated Power Investment Cost. That portion of total project investment cost which is allocated to generation of power based on firm cost allocation of multipurpose projects with power.

b. Available Hours. The hours during which a unit is available. Available Hours (AH) is equal to the sum of Service Hours (SH) plus Reserve Standby Hours (RSH).

c. Balance of Total Investment Cost. The cumulative unpaid federal investment in power facilities. The cost includes the additional federal investments subsequent to the initial placement of generating units in service and the credits for the revenues transferred to the project.

d. Delayed Forced Outage Hours (DFOH). The hours for any malfunction that results in removal of a generating unit from connection to the transmission system for maintenance or repair at a later time, so as to allow an outage to be scheduled after the trouble develops.

e. Equipment Failures and Generation Interruptions. For the purpose of this guidance, equipment failures and generation interruptions are defined as those affecting the project's major power plant equipment which are necessary for generation of hydroelectric power. Such equipment may consist of turbines, generators, transformers, switching equipment, station service system, etc. Also included in this definition is loss of power generation due to project operating procedures and errors, improper or faulty maintenance or work practices. Interruptions due to lightning strikes, outages of non-USACE facilities, and those where impact to service, equipment, cost, etc. is insignificant are excluded.

f. Forced Outage Hours (FOH). The hours for any failure, misoperation, or malfunction that results in the immediate automatic or manual removal of a generating unit from connection to the transmission system, or that prevents such connection from being accomplished when desired.

g. Generator Forced Outage (GFO). Any generating unit forced outage caused by a misoperation, failure or malfunction of a turbine, water passage, governor, or generator, including related auxiliaries or controls. These items are considered to represent a generating unit.

h. Generator Scheduled Outage (GSO). A scheduled outage for a generating unit. (See 1-4.g. above and Note 1 below.)

i. Hours. Hours will be recorded to the nearest hundredth.

j. In-Service Date. The in-service time and date reported in compliance with ER 1130-2-510, Chapter 2, Reports on Hydroelectric Power Generation Statistics.

k. Non-Generator Forced Outage (NGFO). A forced outage caused by misoperation, failure or malfunction of equipment or facilities beyond the load side of the generator terminals.

l. Non-Generator Scheduled Outage (NGSO). A scheduled outage for equipment other than a generating unit. (See 4-4.l. above and Note 1 below.)

m. Period Hours (PH). The number of hours in the year for existing units. For new units, the hours since the unit was first synchronized until the end of the year.

n. Planned Modification Hours (PMH). Scheduled outage for installation of new equipment, switchyard rearrangements or to correct design or construction deficiencies.

Replacement of existing equipment due to failure or normal deterioration is not included. (See Note 1 below.)

o. Reserve Standby Hours (RSH). The hours during which a generating unit is not in service, but is available for use if required.

p. Service Hours (SH). The hours during which a generating unit is connected to the transmission system either supplying power or condensing; i.e., the time during which the generator main power circuit breaker is closed.

q. Scheduled Outage Hours (SOH). The hours for routine repetitive maintenance and repair that have been programmed into the power schedule.

NOTE 1: When a variety of work is performed on both generating unit and non-generating equipment, the primary reason for the outage will determine to which category the outage hours will be charged. Outages due to reservoir conditions, high tailwaters, flood control operations, loss of transmission lines, or short outages for trash removal are not to be considered unavailable time.

CHAPTER 2 - REPORTS ON HYDROELECTRIC POWER GENERATION STATISTICS

2-1. Purpose. This chapter establishes guidance for reporting USACE hydroelectric power statistics, including the availability, failure and usage rates of generating equipment; power generating equipment failures and generation interruptions; monthly power plant generation; and in-service data at multiple-purpose projects having hydroelectric power.

2-2. Background.

a. This pamphlet provides guidance for implementing the following hydropower statistical and informational reporting requirements to Congress and other designated recipients, as defined in ER 1130-2-510, Chapter 2, Reports on Hydroelectric Power Generation Statistics, and for coordinating the operation of the Corps of Engineers hydroelectric generating facilities with the power marketing agencies. Reporting requirements include:

(1) general hydroelectric power generation equipment operational and cost data;

(2) the availability, failure and usage rates of generating equipment at multiple-purpose projects having hydroelectric power;

(3) power generating equipment failures and generation interruptions; and

(4) the in-service dates for hydroelectric generating units and reporting the monthly power plant generation on the Department of Energy Form EIA-759.

b. Section 5 of the Act of December 22, 1944 (PL 534, 78th Congress) provides that electric power and energy generated at reservoir projects under the control of the Department of the Army and in the opinion of the Secretary of the Army not required in the operation of such projects shall be delivered to the Secretary of Interior for transmittal and disposal in a manner to encourage the most widespread use thereof at the lowest possible rates to consumers consistent with sound business principles.

c. Section 302 of the Department of Energy Organization Act (PL 95-91) transfer all functions of the Secretary of Interior under Section 5 of the 1944 Act to the Secretary of Energy together with all other functions of the Secretary of Interior, and officers and components of the Department of the Interior, with respect to Southeastern Power Administration; the Southwestern Power Administration; the Alaska Power Administration; the Bonneville Power Administration; Western Area Power Administration; and the power marketing functions of the Bureau of Reclamation.

2-3. Guidance.

a. Congressional Reports. Section 937, Reports on Hydropower Statistics, PL 99-662, Water Resources Development Act of 1986, states that the Secretary of the Army shall provide to the Committee on Public Works and Transportation of the House of Representatives and the Committee on Environment and Public Works of the Senate, a statistical report on each water resources project constructed by the Army Corps of Engineers which generates electricity. (See Appendix A.)

(1) The report shall specify:

(a) Amount of electricity generated;

(b) Revenues received by the United States from the sale of electricity;

(c) Costs of construction, operation, and maintenance allocated to power; and

(d) Balance owed to the US Treasury by the Power Marketing Administration.

(2) Submission Dates. The report is due to the Congress by the 15th of January each year. The field operating activities will submit to CECW-OM their data by 15 December each year.

b. Service Rates for Generating Equipment.

(1) Each year, on a fiscal year basis, districts having multi-purpose projects with hydropower will determine and report the rates listed below for each hydroelectric project. These rates will be composite for each project, based on the total main unit hours in each category for all units at the project, and computed as indicated in Appendix B.

- In-service operating rate.
- Standby rate.
- Availability rate.
- Generator forced outage rate.
- Non-generator forced outage rate.
- Generator delayed forced outage rate.
- Generator scheduled outage rate.
- Non-generator scheduled outage rate.
- Planned modification outage rate.
- Non-generator delayed forced outage rate.

(2) Service Rate Reports.

(a) Each MSC shall furnish annual reports to HQUSACE (CECW-OM) by 15 February (RCS CECW-0-34) for the previous fiscal year utilizing the Lotus 1-2-3 format provided as ENG Form 4338-E (AUG 89), illustrated in Appendix C. The reports shall be submitted using a diskette or electronic mail.

(b) The additional information shown in Appendix D shall be furnished as a MSC summary report along with an individual summary report for each district having hydroelectric power facilities.

c. Equipment Failure and Generation Interruption Reports.

(1) Project Managers shall report all power generating equipment failures and generation interruptions anticipated to cost in excess of $50,000, or require more than five working days to return equipment to service, to CECW-OM immediately by telephone, facsimile machine (FAX),

or electronic mail (E-mail) and then also in writing. Reports shall be made as soon as possible; however, reports must be furnished before the end of the next regular business day. A sample of the required information is provided as Appendix E.

(2) When requested by CECW-OM, a detailed narrative report shall be prepared and forwarded to CECW-OM as soon as all pertinent information and data on the failure or interruption are available. The report shall present the information and data in such a manner as to facilitate review and evaluation by CECW-OM and other elements of the HQUSACE. These reports are required for review and evaluation for determining what changes are needed in guide specifications, operating and maintenance procedures, or personnel training, to reduce power production interruptions.

(3) Written Report. When requested, a detailed narrative report will be prepared and forwarded to CECW-OM as soon as all pertinent information and data on the failure or interruption are available. The report will include, but not be limited to, the following information as applicable: Name of the project; actual time of day and date of occurrence; identity of equipment or procedure causing the interruption; unit(s) involved; megawatts of project generation shutdown; megawatts of load passing through the project switchyard before interruption; megawatts of switchyard load interrupted; actual or estimated length of time required to return the failed equipment to service; the actual cause of failure or interruption; and any deficiencies found in design, construction, operation or maintenance. The report will also include a description of all actions, interim and final, needed to restore equipment to service, and recommendations for changes in design, construction, protective equipment, operational and maintenance practices and procedures that will reduce the possibility of recurrence. Supporting data, such as single line diagrams, sketches, schematic wiring diagrams, and photographs will be included when such information will clarify the cause of the interruption and assist in determining the best corrective action. The report will present the information and data in such a manner as to facilitate review and evaluation by CECW-OM and other elements of the HQUSACE.

d. Monthly Power Plant (DOE FORM EIA-759) and In-Service Data Reports for Hydroelectric Generating Units.

(1) The Commander, U.S. Army Corps of Engineers (USACE) is required to keep the Chairman, Federal Energy Regulatory Commission, informed of the current installed hydroelectric generating capacity at USACE projects.

(a) This includes installation of new generators and changes in the existing generating capacity due to rewinding of the generator stator, or any other reason. Within five business day after occurrence of the in-service date, the Commander, USACE, will be notified, Attention: CECW-OM, of the name of the project and the nameplate rating in kilowatts of each unit as it is placed in service. The information may be transmitted by telecopy, electronic mail or any other suitable method. The in-service date of a unit is defined as the date when the generator is first brought to rated terminal voltage and synchronized to the transmission system.

(b) For new generators, the date when the generator is initially placed in service, as defined above. For existing generators, the date is when the generator is again placed in operation after a change in capacity. Units declared in service, which subsequently develop trouble requiring modifications that may delay normal generation, will continue to be considered in service, unless otherwise specifically approved by the Commander, USACE. The in-service

date information will agree with the date reported to the Power Marketing Administration and Federal Energy Regulatory Commission.

(c) In service data, for stator rewinds, turbine replacements, or similar work that does not change the nameplate rating of the unit, will be reported only to CECW-OM.

(2) Monthly power Plant Report - Form EIA-759 (OMB No. 1905-0129 and RCS FERC-1001). Each month Energy Information Administration (EIA) of the Department of Energy furnishes USACE field offices with copies of Form EIA-759 for the monthly generation report. This form shall be completed and submitted directly to EIA by the tenth of the following month. In determining net generation, the power used for operation of locks, fishways, flood control, or functions other than power will be included. Power for the operation of the powerhouse and generating equipment only will be deducted from gross generation in computing net generation. A copy of completed Form EIA-759 will be forwarded to CECW-OM for information concurrent with sending the original to the Energy Information Administration. A sample copy of this form is provided as Appendix F.

e. Reports for Power Marketing Agencies.

(1) The Corps is responsible for operating the hydroelectric projects and providing information affecting cost and availability of power to the Power Marketing Agencies. Marketing the power declared excess to the need of the projects and recovering Federal investment are the responsibilities of the Power Marketing Agencies.

(2) Specific Requirements.

(a) Continuing. Prompt written notification will be provided to the appropriate power marketing agency each time a change in power operation or condition which could substantially affect costs or power availability is anticipated.

(b) Annually, when no changes in power operations or costs are expected for the succeeding 12 month period, the marketing agency will be notified of that fact in writing.

(3) MSC Responsibility. The MSCs directly responsible for communicating with the marketing agency will develop reporting procedures in coordination with that agency. This responsibility may be delegated to the District Commander.

CHAPTER 3 - COORDINATION OF HYDROELECTRIC POWER OPERATIONS WITH POWER MARKETING AGENCIES

Reserved.

CHAPTER 4 - PROJECT EMPLOYEE REFRESHER OPERATIONAL EXERCISES FOR EMERGENCY STATIONS, MULTIPLE-PURPOSE PROJECTS WITH POWER

Reserved.

CHAPTER 5 - HYDROELECTRIC POWER PLANT TRAINEES

5-1. Purpose. This chapter establishes the procedures for the Corps of Engineers apprenticeship training program for hydropower trainees for advancement to journeyman status as power plant operators, mechanics, electricians, or electronic mechanics. Guidance for establishing training beyond the apprenticeship program is also included.

5-2. Rationale. Hydroelectric power plants are complex electrical and mechanical installations which need trained personnel for operation and maintenance. The trend towards automation and optimization further emphasizes the importance of a well trained staff to ensure continuity and reliability of power generation. Sufficient number of qualified personnel are not available from the industry to meet the Corps requirements and this necessitates a training program to develop trainees to perform well at journeyman level.

5-3. Selection of Trainees. The vacancies will be filled from any appropriate source, e.g., OPM register, merit promotion action, reassignments, change to lower grade, Veterans' Readjustment Act, Handicap authority, etc. Single-Agency Qualification Standard for Hydroelectric Power Plant Trainee (Army) has been issued by the U.S. Civil Service Commission. Physical requirements are included in the above standard. All candidates, including current Federal employees, must meet these standards. Human Resources will prepare a list of eligible candidates for selection by the MSC Commander or his/her designate.

5-4. Employment Provisions.

a. Trainee Agreement. Each trainee will enter into a written agreement with the local appointing authority. The agreement will specify, but not be limited to:

(1) Local arrangements about tools and supplies.

(2) Trainee's employment and training in an occupation, under standards adequate to produce a qualified skilled worker.

(3) Conditions for advancement and retention, removal from the program, and performance in a full performance position.

(4) Mobility during and after training for Division-wide placement.

(5) Mandatory service for four years after graduating from the program, otherwise the trainee must reimburse Government expenses on pro-rate basis.

b. Probationary Period. The probationary period for a trainee is one year. However, unacceptable performance during the program period will be a cause to remove him from the training program under 5 USC 4303.

c. Pay During Training. Pay rates for trainee levels are established by the Department of Defense Wage Fixing Authority and are shown on current authorized wage schedules. Current Federal employees who enter the training program will have their pay set in accordance with the OPM regulations.

5-5. Training Responsibilities.

a. Headquarters, U.S. Army Corps of Engineers. The Headquarters (CECW-OM) shall be responsible for overview of the training program and keeping the ER current to meet the changing requirements. Any deviations from the program will require approval from CECW-OM.

b. Major Subordinate Command. The MSC Commander is responsible for the overall implementation and management of the program. At his/her discretion, the MSC Commander may delegate all or part of his/her duties to the district commanders as appropriate.

c. District. The District Commander, when so delegated, is responsible for the implementation of the training program. The Chief, Operations Division will see that the training is imparted as stipulated in this EP. He/she will also be an advisor to the District Commander on matters pertaining to the training program.

d. Training Board. A training board shall be established at the MSC or District level, as determined by the MSC Commander. The Board shall consist of a minimum of three members. The Chairman and each Board member shall be directly involved in, and knowledgeable of, operation and maintenance of Corps hydroelectric power plants. The Board shall be responsible for:

(1) Reviewing trainees' requests for reduction in training time and forwarding them to the MSC Commander or his delegatee for approval or denial.

(2) Reviewing and approving course instructions and on-the-job training for trainees granted a reduction in training time.

(3) Evaluating progress of classroom instructions and on-the-job performance of each trainee at the end of each training phase.

(4) Recommending to the MSC commander the hydroelectric power plants to be used as training sites.

(5) Other training related duties as assigned.

e. Training Facility.

(1) Training Coordinator. The Chief, Operations Division, in each district with hydropower training site(s) shall appoint a training coordinator at each training site. The training coordinator will be responsible for scheduling classroom and on-the-job training for all assigned trainees. He/she will also provide assistance and guidance to instructors, as needed, and be responsible for maintaining training records.

(2) Senior Craft-person. The senior craft-person to whom the trainee is assigned for on-the-job training will be responsible to over-see the trainee's work assignments. The senior will make every effort to ensure that the trainee receives the best possible training, and will guide, monitor and evaluate the trainee's work and progress on a daily basis. The senior will also provide to the training coordinator a formal evaluation of the trainee at the completion of trainee's rotational assignment with the senior's crew.

(3) Instructors. The instructors, or project personnel acting in this capacity, will be responsible for providing classroom instructions to the trainees. They should have the demonstrated capability to teach the class and have been at least a senior level craft-person. The instructors are responsible for keeping the training coordinator appraised of the trainee's performance, and for keeping trainees informed of their progress in the classroom.

(4) Trainees. The trainees are responsible for meeting and maintaining standards of Federal employment in their class-room and on-the-job performance and personal work conduct. They are responsible for learning the study material and be able to do the work required in the trade without hazard to themselves or other workers.

5-6. Training Sites. The MSC Commander will select the hydroelectric power projects to be used as training sites. They should be chosen from the larger and more complex projects in the MSC. If feasible, trainees should be transferred between projects while in the training program to broaden their experience.

5-7. Program Details. The training program will consist of a combination of academic, plant equipment study, and on-the-job training. The academic training will be imparted by enrolling in a correspondence school for academic subjects and class room (or equivalent) instructions for plant equipment. On-the-job training will be achieved by orderly progression through practical assignments closely related to correspondence school subjects and plant equipment instructions.

a. Training Period. A four-year training and development program will be required for all entrants who do not have previous hands on experience, and academic or vocational education beyond the entry level requirements.

b. Reduced Training Period. Reductions in time required to complete the training program may be granted by the MSC Commander for the prior experience or training, provided that the trainee applies for such reduction before completing the first year of the standard program. The trainee will be responsible for providing the satisfactory proof of experience or training he or she cites as creditable for a reduction in training time. Acceptable proof will be academic transcripts and course descriptions from accredited vocational schools, colleges or community colleges, and statements from former supervisors outlining previous work experiences, level of responsibility, and performance appraisal. Only one reduction will be granted. If the MSC Commander grants a trainee a reduction in time of the training period, the training coordinator shall prepare a training schedule which will insure that the trainee has an opportunity to develop the same skills and knowledge by the end of the reduced training period as a full four year program trainee would have. This training schedule must be approved by the training board. Trainees granted a reduction in training time will have their progress evaluated in the same manner as a full 4-year term trainee.

c. Craft Selection. The first one year of the training program will be identical for all crafts. Specialization will begin in the second year. Each trainee will be asked to express a preference for the craft specialty desired. Depending on the needs of power plants and trainee's aptitude and talents, the training board will assign a craft specialty, subject to the approval by the MSC commander, to each trainee before the beginning of the specialization phase. The training board will document the basis on which assignment was based.

d. Deviation from the Standard Program. Any deviation from the standard four year program as stated herein, or material changes in classroom subjects, shall be submitted to

HQUSACE, ATTN.: CECW-OM for approval. No such changes shall be incorporated without prior approval of HQUSACE.

5-8. Training Program Schedule.

a. General. The first year of the training program consists of approximately 60% on-the-job training at a Corps hydroelectric power project, and 40% training in trade theory and closely related academic subjects. The next three years of the program consists of approximately 80% on-the-job training at a Corps hydroelectric power plant, and 20% training in trade theory and closely related academic subjects.

b. Academic Instructions. Craft persons are required to know the basic physical principles of the equipment they use. They are also required to read and understand reasonably complex written instructions, and be able to write legible, meaningful reports. Instructions in academic subjects should preferably be provided by professional teachers. This could be accomplished through a local school system if it is located nearby and is easily accessible. If professional classroom training is not practical because of geographic distance, then correspondence courses (Appendix G) or other delivery methods covering the same general subjects should be provided to the trainees.

c. Plant Equipment Study. The plant equipment study is designed to provide a trainee with the theory and operation of the hydroelectric plant equipment. Appendix G lists the topics for formal instructions. The theory portion of the instructions may be obtained through correspondence school courses subject to the approval of the training board. However, a qualified trade theory instructor must be provided to the trainees to insure that the trainees are receiving the best quality instructions and counseling.

d. On-the-Job Training. This portion of training is critical. Work habits, methods, and techniques developed in this phase of training can make the trainee an efficient and effective craft person. The training coordinator, in consultation with power plant superintendent, will prepare an on-the-job schedule for each trainee. The trainee should work on as many jobs as practicable, keeping in mind the desirability of completing a task from start to finish. Also, the trainee will be assigned to work with craft persons who have a special capability for the assigned task.

5-9. Training Evaluation. Each trainee's progress will be evaluated periodically and at the end of each phase as described below.

a. Periodic Evaluation. Each trainee's academic and on-the-job progress will be continually monitored by the instructors and craft seniors. The purpose of the evaluation is to assess the trainee's progress and the effectiveness of the instructional process. These evaluations are necessary so that any incipient problems can be exposed at the earliest possible time. The training coordinator should also consider evaluations from the trainee's instructors, crafts seniors and correspondence school.

b. Phase Evaluation. At the end of each training phase (approximately six months), every trainee will be evaluated by the training board. The evaluation will have a written portion, an oral portion and a demonstration of practical skills, and will cover both academic and on-the-job portions of the program. These evaluations will be used as a part of the procedure to assess a trainee's progress for determining fitness to remain in the program, and as an input to the trainee's

performance appraisal. The minimum requirement for passing a phase evaluation is a score of 70% overall and 70% on each correspondence school instruction unit or classroom course. Upon satisfactory completion of the phase evaluation and other performance requirements, the trainee will be advanced to the next training phase.

5-10. Failure to Maintain Satisfactory Progress. Each trainee is responsible for maintaining satisfactory progress in academic studies and on-the-job training. The evaluations will determine the trainee's progress. Non-satisfactory evaluations will be handled as below:

a. Failing Periodic Evaluations. If the results of a periodic evaluation are unsatisfactory, the appropriate supervisor will discuss the results with the trainee, determine reasons for unacceptable progress, counsel the trainee on improvements needed, provide an appropriate improvement period as prescribed by the Office of Personnel Management (OPM) regulations, provide the trainee with appropriate assistance, and give the trainee a make-up performance test at the end of improvement period. If the trainee's performance is unsatisfactory in two consecutive makeup evaluations, a recommendation shall be made to the training board to remove that trainee from the training program. The training coordinator or appropriate supervisor shall ensure that any trainee who is having a problem with satisfactory performance is placed with at least one other craft person before beginning of the remedial period leading to probable removal from the training program.

b. Failing Phase Evaluations. If the result of a phase (6-month) evaluation is unsatisfactory, the training board will inform the appropriate supervisor. The supervisor will notify the trainee in writing of unsatisfactory performance, inform the trainee of the specific deficiencies, what the trainee must do to overcome the deficiencies, provide an appropriate improvement period, and provide the trainee with appropriate assistance. At the end of the improvement period, the training board will re-administer the phase evaluation. Failure at two consecutive phase evaluations or three non-consecutive phase evaluations any time during the training period shall require removal of the trainee from the training program in accordance with the OPM regulations.

5-11. Training Accomplishments. After successful completion of four years of training, as prescribed in this EP, a trainee will be eligible to advance to journeyman status and should have the academic knowledge and practical skills for his respective trade as described in Appendix H.

5-12. Training Records. Complete training and performance evaluation records will be maintained for each trainee. A set of obsolete forms are enclosed in Appendix I to illustrate the types of records needed for each phase of the program.

5-13. Certificate of Completion. Each trainee who successfully completes the training program will be presented with a Certificate of Training on DA Form 87, included as Appendix J.

5-14. Training at the Journeyman Level. {FUTURE}

CHAPTER 6 - REWIND OF HYDROELECTRIC GENERATORS AND GENERATOR MOTORS

6-1. Purpose. This chapter establishes guidance on replacement of generator stator windings, generators, or other comparable large scale electro-mechanical components of a USACE hydroelectric power generating facility.

6-2. Background.

a. This guidance is designed to assist hydropower managers in providing higher authority with a uniform and consistent rationale for replacing a generator or generator/motor winding. It also provides the framework for justifying the replacement of a generator stator winding as part of a major rehabilitation program.

b. The goal of this rewind procedure is to develop a decision document that justifies a generator winding replacement before a catastrophic failure. That decision depends on adequately describing the condition of the winding and displaying the economic justification to support the decision.

6-3. Guidance.

a. Replacement of generator stator windings shall be based upon the factors found in Appendixes K, L and M. Each unit will be considered on its individual merits. Brief reports shall be prepared that contain this evaluation. Consideration shall be given to uprating the unit, whenever replacement of the winding is contemplated. Appendix N is a partial listing of technical standards.

b. The factors identified in subparagraphs (1) and (2) shall be addressed in the report as a basis to support the need for a generator rewind. The additional factors in subparagraph 3 shall be addressed to support generator uprating, if recommended, and shall be included in the report. If generator uprating is not recommended, the report shall address the factor or factors which makes an uprating not feasible. In accordance with ER 1110-2-109, Hydroelectric Design Center will prepare the engineering and design features of the reports and other engineering documentation.

(1) Background Information. Provide a tabulation of pertinent data for the existing generator, turbine, transformer and other associated equipment. See Appendix K.

(2) Rewind Evaluation. Provide an analysis of the need for any proposed rewind that considers the condition of the existing winding and the impact of forced rewind if a scheduled rewind is not accomplished. The analysis should be developed around Appendices L and M.

(3) Potential for Uprating. If uprating is recommended, an analysis shall be prepared to demonstrate that an uprating is justified based on the following factors:

(a) Compatibility of new winding with existing generator circuit breaker, excitation equipment, transformer, buswork, structural, etc.

(b) Hydrology (turbines, water availability): Additional mechanical power capability to increased generation.

(c) Marketability of the increased capacity and/or energy, see Section 103(c)(1), Public Law 99-662, (WRDA 86).

(d) Environmental impacts, see Section 216, Public Law 104-303, (WRDA 96).

(e) Economic justification.

FOR THE COMMANDER:

OTIS WILLIAMS
Colonel, Corps of Engineers
Chief of Staff

14 APPENDIXES
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APPENDIX A

U. S. ARMY CORPS OF ENGINEERS
HYDROPOWER STATISTICS-FY 1994
RCS: CECW-0-73

Division	Project	Generation Mega Watt-hours	Revenues, Sale of Electricity Dollars		Allocated Investment Cost-Dollars	Balance of Investment Cost-Dollars	Operation Cost-Dollars	Maintenance Cost-Dollars	Total O&M Cost-Dollars
			Gross (PMA)	Net (Corps)					
LMVD	Blakely Mt.	205,971		2,301,200	27,308,811	12,506,866	885,205	369,930	1,255,135
	C. Cannon	149,588		4,649,500	97,535,160	88,648,908	716,953	210,642	927,595
	DeGray	98,586		1,378,000	23,256,801	19,607,415	566,098	267,773	833,871
	Narrows	45,572		1,051,700	7,925,400	3,665,434	596,417	248,946	845,363
	Subtotal-LMVD	499,717		9,380,400	156,026,172	124,428,623	2,764,673	1,097,291	3,861,964
MRD	Big Bend	842,201		5,227,506	115,655,211	70,708,067	2,926,352	1,548,677	4,475,029
	Ft Peck	823,863		1,471,982	122,848,945	92,941,165	2,299,764	1,521,246	3,821,010
	Ft Randall	1,590,246		4,722,098	137,960,505	82,174,732	2,308,096	2,243,261	4,551,357
	Garrison	1,763,826		1,440,286	206,438,679	141,211,881	3,478,886	1,958,799	5,437,685
	Gavins Point	731,313		2,840,570	48,964,739	30,881,963	1,435,894	1,235,045	2,670,939
	Harry S. Truman	229,434		6,204,900	155,637,527	144,222,115	1,208,849	1,724,614	2,933,463
	Oahe	2,361,763		414,748	238,090,803	162,370,692	2,555,080	1,902,575	4,457,655
	Stockton	112,634		1,239,400	19,023,142	15,279,868	366,537	546,313	912,850
	Subtotal-MRD	8,455,280		23,561,490	1,044,619,551	739,790,483	16,579,458	12,680,530	29,259,988
NCD	St. Marys	147,521		1,857,287	12,343,154	4,938,860	710,860	801,385	1,512,245
	Subtotal-NCD	147,521		1,857,287	12,343,154	4,938,860	710,860	801,385	1,512,245

APPENDIX B

RATE COMPUTATIONS

B-1. OPERATING RATE = (SH/PH) x 100%

B-2. STANDBY RATE = (RSH/PH) x 100%

B-3. AVAILABILITY RATE = ((SH + RSH)/PH) x 100%

B-4. GENERATOR FORCED OUTAGE RATE = (GFOH/(PH)) x 100%

B-5. NON-GENERATOR FORCED OUTAGE RATE = (NGFOH/(PH)) x 100%

B-6. GENERATOR DELAYED FORCED OUTAGE RATE = (GDFOH/PH) x 100%

B-7. NON-GENERATOR DELAYED FORCED OUTAGE RATE = (NGDFOH/PH) x 100%

B-8. GENERATOR SCHEDULED OUTAGE RATE = (GSOH/PH) x 100%

B-9. NON-GENERATOR SCHEDULED OUTAGE RATE = NGSOH x 100%

B-10. PLANNED MODIFICATION OUTAGE RATE = (PMH/PH) X 100%

APPENDIX C

GENERATING EQUIPMENT SERVICE SUMMARY (EP 1130-2-510)						REPORTS CONTROL SYMBOL CECWO-O-34
E.E.I. EQUIV.		ITEM		NUMBER	TOTAL HOURS	SERVICE RATES (PERCENT)
PH		MAIN GENERATORS				XXXXXXXXXXXX
SH		SERVICE HOURS		XXXXXXXXXXXX		
RSH		STAND-BY HOURS		XXXXXXXXXXXX		
AH		(TOTAL AVAILABLE HOURS)				
FOH		FORCED OUTAGES	GENERATOR			
			NON GENERATOR			
SOH	MOH	DELAYED FORCED OUTAGES	GENERATOR			
			NON GENERATOR			
	POH	SCHEDULED OUTAGES	GENERATOR			
			NON-GENERATOR			
		PLANNED MODIFICATION OUTAGES				
		(TOTAL UNAVAILABLE HOURS)		XXXXXXXXXXXX		XXXXXXXXXXXX

REMARKS:

THIS FORM IS AVAILABLE THROUGH ELECTRONIC GENERATION ONLY

FISCAL YEAR	DIVISION/DISTRICT/PROJECT SUMMARY

[illegible]

APPENDIX D

MSC SUMMARY REPORT FORMAT FOR HYDROPOWER GENERATION

1. Total main generators at end of year.

2. Total possible main unit hours. This will be the PH multiplied by the units listed in 6a except for those units put in service during the year. Hours for these latter units start at the in-service date.

3. The total in-service hours (SH) for all main units.

4. The total standby hours (RSH) for all main units.

5. The total available hours (AH) for all main units.

6. The total number of generator forced outages for all main units.

7. The total out-of-service hours for all main units as a result of generator forced outage.

8. The total number of non-generator forced outages for all main units.

9. The total out-of-service hours for all main units as a result of non-generator forced outages.

10. The total out-of-service hours for all main units as a result of generator delayed forced outage.

11. The total out-of-service hours for all main units as a result of non-generator delayed forced outages.

12. The total out-of-service hours for all main units as a result of generator scheduled outages.

13. The total out-of-service hours for all main units as a result of non-generator scheduled outages.

14. The total out-of-service hours for all main units as a result of planned modification outages.

15. The rates listed in 1 thru 14 above, computed as composites from the totals for all main units in the district.

16. A resume of any special problems or actions that had a noticeable effect on the rates and indicating to what degree the rates were affected.

APPENDIX E

EQUIPMENT FAILURE AND SYSTEM DISTURBANCE TELEPHONE REPORT

1. REPORTED BY DISTRICT: Tulsa District TIME: 1300 DATE: 7 Jun95

2. PROJECT: Eufaula EQUIP.FAIL.TIME: 0844 DATE: 7 Jun95

RETURNED TO SERVICE: 1500 DATE: 14 Jun95

3. UNIT OF EQUIPMENT: Power transformer for Unit #2 Solid State Exciter.

4. DESCRIPTION OF FAILURE: Phase B of regulator power transformer failed blowing the high voltage fuse on that phase. Protective relays for regulator tripped auxiliary relay 5c shutting down the generator.

5. LOAD INTERRUPTED MW: 34 FROM: 0844 7 Jun95 TO: 1500 14 Jun95

6. CAPACITY OUTAGE MW: 30 FROM: 0844 7 Jun95 TO: 1500 14 Jun95

7. EFFECT ON CONNECTED SYSTEM: Loss of 30 MW of reserve capacity.

8. PROBABLE CAUSE: Defective transformer insulation.

9. CORRECTIVE ACTION: Transformer removed and taken to local repair shop by plant personnel. Phase B was rewound and transformer reinstalled.

10. DEFICIENCIES: No known deficiencies.

11. REMARKS: 10 minutes before regulator transformer failure transmission line #2 (PSO line to Stigler OK) tripped after a cross arm broke. The line relays operated properly (carrier ground tripped line) leaving all three generators on line feeding lines 1 and 3. When the line tripped generator voltage peaked at 14.2kv. I estimate unit will return to service the middle of next week.

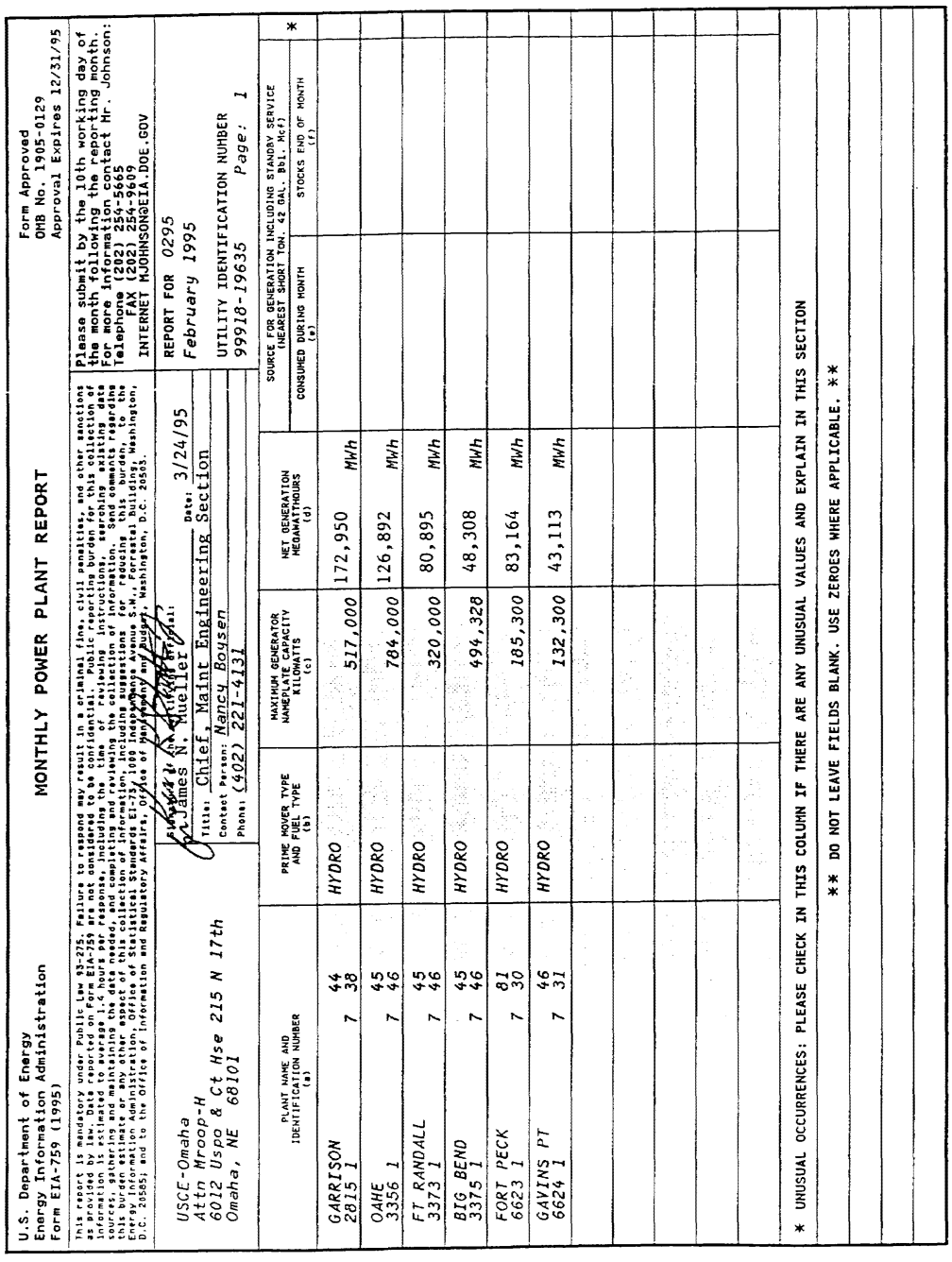
12. PARTIAL REPORT: FINAL REPORT: XXXX

NA = Not applicable
NK = Not known
E = Estimated
A = Actual
* = Mfg & Type

CALL TAKEN BY: Westmeyer

APPENDIX F

MONTHLY POWER PLANT (DOE FORM EIA-759) REPORT



U.S. Department of Energy
Energy Information Administration
Form EIA-759 (1995)

MONTHLY POWER PLANT REPORT

Form Approved
OMB No. 1905-0129
Approval Expires 12/31/95

This report is mandatory under Public Law 93-275. Failure to respond may result in a criminal fine, civil penalties, and other sanctions as provided by law. Data reported on Form EIA-759 are not considered to be confidential. Public reporting burden for this collection of information is estimated to average 1.4 hours per response, including the time of reviewing instructions, searching existing data sources, gathering and maintaining the data needed, and completing and reviewing the collection of information. Send comments regarding this burden estimate or any other aspect of this collection of information, including suggestions for reducing this burden, to the Energy Information Administration, Statistics and Methods Group, EI-70, Forrestal Building, Washington, D.C. 20585; and to the Office of Information and Regulatory Affairs, Office of Management and Budget, Washington, D.C. 20503.

Please submit by the 10th working day of the month following the reporting month.
For more information contact Mr. Johnson:
Telephone (202) 254-5661
FAX (202) 254-9609
INTERNET MJOHNSON@EIA.DOE.GOV

USCE-Omaha
Attn Mroop-H
6012 Uspo & Ct Hse 215 N 17th
Omaha, NE 68101

Signature of Official: James N. Mueller
Date: 3/24/95
Title: Chief, Maint Engineering Section
Contact Person: Nancy Boysen
Phone: (402) 221-4131

REPORT FOR 0295
February 1995
UTILITY IDENTIFICATION NUMBER
99918-19635 Page: 1

PLANT NAME AND IDENTIFICATION NUMBER (a)	PRIME MOVER TYPE AND FUEL TYPE (b)	MAXIMUM GENERATOR NAMEPLATE CAPACITY KILOWATTS (c)	NET GENERATION MEGAWATTHOURS (d)	SOURCE FOR GENERATION INCLUDING STANDBY SERVICE (NEAREST SHORT TON, 42 GAL. BBL. Mcf)		*
				CONSUMED DURING MONTH (e)	STOCKS END OF MONTH (f)	
GARRISON 7 44 2815 1 38	HYDRO	517,000	172,950 MWh			
OAHE 7 45 3356 1 46	HYDRO	784,000	126,892 MWh			
FT RANDALL 7 45 3373 1 46	HYDRO	320,000	80,895 MWh			
BIG BEND 7 45 3375 1 46	HYDRO	494,328	48,308 MWh			
FORT PECK 7 81 6623 1 30	HYDRO	185,300	83,164 MWh			
GAVINS PT 7 46 6624 1 31	HYDRO	132,300	43,113 MWh			

* UNUSUAL OCCURRENCES: PLEASE CHECK IN THIS COLUMN IF THERE ARE ANY UNUSUAL VALUES AND EXPLAIN IN THIS SECTION

** DO NOT LEAVE FIELDS BLANK. USE ZEROES WHERE APPLICABLE. **

APPENDIX G

HYDROELECTRIC POWER PLANT PERSONNEL TRAINING PROGRAM

TABLE OF CONTENTS

SPECIALIZED TRAINING - OPERATOR

HYDROELECTRIC POWER PLANT PERSONNEL TRAINING PROGRAM
CORRESPONDENCE COURSES

TRAINEE IA AND IB

ICS Course	Text Titles	Units
	TRAINEE IA	
2750 A-F	Practical Arithmetic	6
4210 A-C	Electricity	3
6635	Electrical Blueprint Reading	1
2001	Introduction to Electronics	1
6719 A-B	Elements of Print Reading	2
2002 A-B	Electronics	2
	SUB-TOTAL	15
	TRAINEE IB	
2468	Formulas	1
6426 A-B	Principles of Mechanics	2
2508	OSHA: Occupational Safety and Health Act	1
2469 A-B	Algebra	2
2509 A-E	Industrial Safety	5
6718 A	Hydraulic Turbines	1
6589 A	Electric Power Generating Station	1
	Sub-Total	13
	TOTAL	28

PLANT EQUIPMENT STUDY OUTLINE

TRAINEE IA

I. Safety:

A. Clearance Procedure
1. Types of Clearances
2. Types of Cards
3. Switching Orders

B. Code Call
1. Operation

C. Equipment Safety Measures
1. Wheel Pit
2. Remote Sites
3. Switchyard

D. Hazardous Areas
1. Battery Room
2. Oil Storage
3. Fixed CO Protected Spaces
4. Metal Enclosed Switchgear
5. Tailrace and Gate Decks
6. Remote Sites (microwave repeater site, etc.)

II. Electrical/Electronic Diagrams

A. Symbols
1. Electrical
2. Electronic

B. Use

III. Mechanical Prints

A. Symbols
B. Use

IV. Main Generating Units

A. Generator
1. Main Components
2. Rating
3. Operations

B. Turbine
1. Main Components
2. Rating
3. Operations

V. Fire Fighting Equipment and Alarms

A. Types of Fires
B. Types of Fire Fighting Equipment
C. Alarms

VI. Definitions

A. Hydraulic
B. Electrical
C. Power

VII. Soldering Techniques

A. Mechanical Strength
B. Electrical Connection
C. Selection of Materials

PLANT EQUIPMENT STUDY OUTLINE

TRAINEE IB

I. Safety and First Aid

A. CO_2
1. Hazards
2. Safety Precautions
B. Emergency breathing Equipment
1. Type
2. Location
C. Protective Equipment
1. Ear
2. Eye
3. Foot

II. Turbine and Gates

A. Types
1. Turbine
2. Gates
B. Operation
1. Turbine
2. Gates
C. Construction

1. Gates

III. Miscellaneous Electrical

A. Circuit Breakers
1. Rating
2. Operating Mechanism
3. Control Circuits

B. Motor Operated Disconnects
1. Rating
2. Operation
3. Control Circuits

IV. Air Systems

A. Station Air
1. Operating Pressure

B. Brake Air
1. Operating Pressure

C. Governor Air
1. Operating Pressure

V. Air Compressors

A. Cooling
1. Methods

B. Systems
1. Diagrams

VI. CO_2 System

A. Uses and Hazards
1. Safety Precautions

B. Systems
1. Generator
2. Oil
3. Other

CORRESPONDENCE COURSES

ELECTRICIAN TRAINEE IIA AND IIB

ICS Course No.	Test Titles	Units
	TRAINEE IIA	
4410	Getting Started As An Electrician	1
6589 B	Electric Power Generating Stations	1
6634 A-B	Electrical Schematic Diagrams	2
2443	Going Metric	1
5567	Practical Geometry and Trigonometry	1
5004 A	Benchwork - Part 1	1
3500 A	Measuring Instruments	1
2469 C-E	Algebra	3
5011	Elements of Chemistry (Reference Only)	1
2007 A	Solid State Circuits	1
6238 A-B	Industrial Accident Prevention	2
		Sub-Total 15
	TRAINEE IIB	
4030 A-B	D-C Machines	2
6687	D-C Generators and Motors	1
2007 B-C	Solid State Circuits	2
6718 B	Hydraulic Turbines	1
1842 A-C	Reading Architect's Blueprints	3
4031	Alternators	1
3521 A-B	Drilling	2
2246 A-B	Erecting	2
2542	Fasteners	1
		Sub-Total 15
		TOTAL 30

PLANT EQUIPMENT STUDY OUTLINE

ELECTRICIAN TRAINEE IIA

I. Clearances

- A. Protective Cards
- B. Hold Orders
- C. Placing of Protective Grounds

II. Switching

- A. Switching Order
- B. Precautions When Switching

III. Water Systems

- A. Definitions
- B. Raw Water System
- C. Potable Water System

IV. Direct Current Systems

- A. Description of Systems
- B. Batteries
  1. Types
  2. Charges
- C. Emergency Lighting

V. Excitation Systems

- A. Description
- B. Purpose
- C. Operation

PLANT EQUIPMENT STUDY OUTLINE

ELECTRICIAN TRAINEE IIB

I. Station Service

- A. Precautions
- B. Description
- C. Operation

II. Power Transformers

- A. Ratings
- B. Purpose
- C. Precautions

III. Governors

- A. Purpose
- B. Type
- C. Operation
  1. Oil Pressure
  2. PMG
  3. Overspeed

IV. Limits, Alarms, and Name Plates

- A. Load Limits
- B. Temperature Limits
  1. Generators
  2. Transformers
- C. Name Plate Data
  1. Generators
  2. Exciters
  3. Transformers
- D. Annunciation
  1. Description

V. Protective Relays

- A. Description
- B. Purpose
- C. Operation

CORRESPONDENCE COURSES

ELECTRICIAN TRAINEE III A AND III B

ICS Course No.	Text Title	Units
	TRAINEE IIIA	
6720 A-B	Reading Shop Prints	2
40108 A-C	Electricity and Magnetism	3
4040	Transformers	1
4042	Distribution and Power Transformers	1
6613	Switchgear	1
4146 A-C	Electrical Measuring Instruments	3
6698	A-C Motors, Generators, and Rectifiers	1
6631 A-B	A-C Motor Repair	2
4220 A-B	Repairing D-C Motors and Generators	2
		Sub-Total 16
	TRAINEE IIIB	
4033	Fractional Horsepower Motors	1
4034	Repairing Fractional Horsepower Motors	1
6699 A-C	Industrial Motor Control	2
6585	Reconnecting Induction Motors	1
6682	Electric Lamps	1
4305	Lighting Control	1
4402 A-B	Conduit and Conductors	2
4300 A-C	Electric Wiring	3
4343	Storage Batteries	1
		Sub-Total 14
		TOTAL 30

PLANT EQUIPMENT STUDY OUTLINE

ELECTRICIAN TRAINEE IIIA

I. CLEARANCE PROCEDURES

A. This will cover every thing pertaining to clearance procedures.

II. TEST INSTRUMENTS

- A. Megger
  - 1. Theory of operation
  - 2. Where used
- B. Multimeter
  - 1. Theory of operation
  - 2. Where used
- C. Clamp on Ammeter
  - 1. Theory of operation
  - 2. Where used
- D. Other types

III. SELSYN SETS

- A. Theory of operation
- B. Where utilized
- C. Operation
- D. Maintenance

IV. DISCONNECT SWITCHES

- A. Types
  - 1. Manual
    - a. Ratings
    - b. Operation
    - c. Contact Surfaces
  - 2. Motor Operated
    - a. Control Circuits
    - b. Operating Mechanism
    - c. Contact Surfaces

V. INTERLOCKS

- A. Purpose and Types
  - 1. Generators
  - 2. Breakers
  - 3. Discounts
  - 4. Metal clad switchgear
  - 5. Control circuits (relay, etc.)
  - 6. Governors

VI. AIR CIRCUIT BREAKERS - 15 KV AND 480 V

- A. Type
  - 1. 13.8 KV ACB
    - a. Operation (Prints)
    - b. Inspection
    - c. Maintenance
  - 2. 480 v ACB
    - a. Operation
    - b. Inspection
    - c. Maintenance
  - 3. Molded Case Breakers
    - a. Tests
    - b. Overloads
    - c. Maintenance

VII. POWER TRANSFORMERS

- A. Main Transformers
  - 1. Description
  - 2. N_2 Blanket
  - 3. Alarms
  - 4. Cooling (number pumps, power supply, water supply, coolers, etc.)
  - 5. TRO's
- B. Station Service Transformers
  - 1. Description
  - 2. Cooling

VIII. TRIPPING TESTS

- A. Methods
- B. Safety

PLANT EQUIPMENT STUDY OUTLINE

ELECTRICIAN TRAINEE IIIB

I. ANNUNCIATOR SYSTEM

- A. Components
  - 1. Relays
  - 2. Trouble Contacts
  - 3. DC Supply
- B. Schematic Diagrams
- C. Maintenance

II. PREVENTIVE MAINTENANCE

- A. Responsibilities
- B. Purpose
- C. Record Keeping

III. ELECTRICAL MAINTENANCE

- A. Insulating Materials
  - 1. Tapes
  - 2. Varnish
  - 3. Others
- B. Protective Coatings
  - 1. Varnish
  - 2. Phenolic

IV. FLOW METERS

- A. Operation
- B. Testing
- C. Adjustment
- D. Calibration
- E. Maintenance

V. CODE CALL SYSTEM

- A. Description
- B. Operation
- C. Maintenance

VI. OCB's/GCB's

- A. Description
  - 1. Operating Mechanism
  - 2. Bell Crank, Operating Rod, Tail Spring, Trip Free
  - 3. Control Circuit
  - 4. Interrupter
  - 5. X and Y Relays
  - 6. Pressure Switches
- B. Maintenance
  - 1. Inspection
  - 2. Breaker Timer
  - 3. Draining and Filling with Oil/SF_6

VII. INSULATING OIL/GAS

- A. Type
- B. Where Used
- C. Purifying Insulating Oil
  - 1. Filter Press
  - 2. Centrifuge
- D. Insulating Oil/Gas Flow Diagram
- E. Testing of Insulating Oil/Gas

VIII. STORAGE BATTERIES

- A. Description
  - 1. Number of Cells
  - 2. Type of Cells
  - 3. Maintenance
  - 4. How Connected
- B. Chemical Action
  - 1. When in Normal Use
  - 2. When Charging
  - 3. Overcharging
  - 4. Safety Precautions

IX. BATTERY CHARGERS

- A. Description
  - 1. Type
  - 2. Characteristics
  - 3. Power Supply
  - 4. Capacity
- B. Control
  - 1. How Operated
  - 2. Control Circuit (DC/AC)

CORRESPONDENCE COURSES

ELECTRICIAN TRAINEE IV-A AND IV-B

ICS Course No.	Text Titles	Units
	TRAINEE IVA	
6538 A-B	Protective Relaying	2
4312	Electric Space Heating	1
2531 A-B	Lubrication	2
2602	Bearings and Seals	1
5177	National Electric Code	1
4368	Voltage Regulators for Generators	1
6686	Local Distribution of Electric Power	1
5959 A-B	Underground Power Systems	2
2020	Basic Electronic Components and Schematics	1
2021	Understanding and Using Electronic Diagrams	1
6636	Controls For Air Conditioning	1
		Sub-Total 14
	TRAINEE IVB	
4019 A-B	Electric Power Measurements	2
4342	Efficiency Tests	1
4341	Industrial Motor Applications	1
2089 A-H	Electronics in Industry	8
6617	Inductance and Capacitance	1
6235 A	Inventory Control	1
		Sub-Total 14
		TOTAL 28

PLANT EQUIPMENT STUDY OUTLINE

ELECTRICIAN TRAINEE IVA

I. CLEARANCE PROCEDURES AND SAFETY

II. RELAYS

- A. Types
- B. Zone of Protection
- C. Generator
- D. Turbine
- E. Transformer
- F. Lines

III. LIGHTING ARRESTERS AND HIGH VOLTAGE FUSES

- A. Theory of Operation
- B. Breakdown and Reseal Voltages
- C. Maintenance and Inspection

IV. HEATING, VENTILATING AND AIR CONDITIONING

- A. Electrical Operation (Prints)
- B. Mechanical Operation (Flow Diagrams)
- C. Maintenance

V. POWERHOUSE CRANE

- A. Electrical
  1. Source of Supply
  2. Controls
  3. Operation
  4. Limit Switches

V. POWERHOUSE CRANE (Cont.)

- B. Mechanical
  1. Hoist
  2. Cable Drums
  3. Cables
- C. Capacity
  1. Main Hoists
  2. Auxiliary Hoists
- D. Maintenance

VI. CARRIER CURRENT

- A. Definition
- B. How Used in Relaying

PLANT EQUIPMENT STUDY OUTLINE

ELECTRICIAN TRAINEE IV B

NOTE: Since this is the "topping out" examination, the study questions for phases 1A, 1B, 2A, 2B, 3A, 3B and 4A are to be included and selected questions will be asked to determine the understanding and retention of all previous training.

I. MAIN GENERATORS (complete)

- A. Starting, Stopping (Automatic, Using Print)
- B. Complete Unit Description (Using Prints)
- C. Voltage Regulation (Print)

II. RECORDERS: TEMPERATURE, LOAD, AND FREQUENCY

- A. Theory of operation
  1. Measuring Circuits
  2. Secondary Functions
- B. Maintenance
  1. Adjustments
  2. Cleaning
  3. Calibration

III. SUPERVISORY SKILLS

- A. Planning, Organizing, Working Knowledge of Job
- B. Performance Appraisals and Job Description
- C. Training and Development

IV. TELEPHONE SYSTEM

- A. Operation
- B. Maintenance

V. SPECIALIZED SAFETY TECHNIQUES

- A. Cleaning generators, polishing shafts, scaffolds, ladders, safety belts, etc.

VI. TELEMETERING

- A. Principles
- B. Types
  1. Voice
  2. Metering

VII. REMOTE CONTROL EQUIPMENT

- A. Principles and Features of Operation
- B. Maintenance

VIII. LINE RELAYS AND GROUND DETECTOR SYSTEMS

- A. Principles of Operation of Line Relays
- B. Ground Detector Systems (AC and DC)

IX. MAINTENANCE OF PORTABLE POWER TOOLS

- A. Inspection
- B. Preventative Maintenance
- C. Recording Data

X. GANTRY CRANE

- A. Description
- B. Operation
- C. Maintenance

XI. INSPECTIONS

A. Motor Control Centers
   1. Breakers
   2. Contractors
   3. Space Heaters
   4. Wiring
   5. Terminal Blocks

B. Motors
   1. Windings
   2. Commutators and Slip Rings
   3. Wiring
   4. Insulation

C. Generators
   1. Exciters
   2. Speed Switches
   3. Windings
   4. Surge Protection
   5. ACB

D. Recording Data

E. Clearance Procedure

CORRESPONDENCE COURSES

ELECTRONICS MECHANIC TRAINEE IIA AND IIB

ICS Course No.	Text Titles	Units
	TRAINEE IIA	
X0105-X0111	Practical Math and Measurements	7
X0507	Electronic Drawings	1
X0606,X0608,X0609	Industrial Materials and Components	3
XO401-X0404	Hand and Power Tools	4
A0206	Rectification and Electronic Devices	1
A0301-A0306	Electrical Measurements and Instruments	6
B0101-B0106	Electronic Measurements and Instruments	6
		Sub-Total 28
	TRAINEE IIB	
B0201-B0204	Reactive Circuits	4
B0301-B0306	Electronic Components	6
B0401-B0408	Basic Electronic Circuits	8
6660	Radio Communications Fundamentals	1
6491	Radio-Electronic Telemetry	1
6511 A-C	Two-Way Radio Systems	3
2173	Transmitter Tests and Measurements	1
6515	Radio-Frequency Circuits	1
5801	Antennas and Radiation	1
		Sub-Total 26
		TOTAL 54

PLANT EQUIPMENT STUDY OUTLINE

ELECTRONICS MECHANIC TRAINEE IIA

I. Clearance Procedures

II. Hand Tools

III. Definitions - Electronic, Electrical

IV. Diagrams - Electronic, Electrical, Telephone

V. Power Supplies

- A. Batteries
- B. Chargers
- C. A-C Power Supplies

D. Rectifiers

VI. Oscillator Circuits

VII. Test Equipment

A. Multimeters
B. Oscilloscope
C. Grounding and Insulation

VIII. Radio Installation, Vehicle

PLANT EQUIPMENT STUDY OUTLINE

ELECTRONICS MECHANIC TRAINEE IIB

I. Radios

A. AM
B. FM
C. SSB

II. Microwave

III. Public Address Systems

IV. Lightning Protection

V. Test Equipment - Includes Safety

VI. Cables - RF, Audio, Fiber Optic, Telephone

CORRESPONDENCE COURSES

ELECTRONICS MECHANIC TRAINEE IIIA AND IIIB

ICS Course No.	Text Titles	Units
	TRAINEE IIIA	
B0501-B0508	Electronic Systems	8
B0601-B0606	Troubleshooting Electronic Equipment and Systems	6
B0701-B0707	Pulse Circuits	7
	Sub-Total	21

TRAINEE IIIB

B0801-B0808	Logic Circuits	8
B0901-B0906	Linear and Digital Integrated Circuits	6
B1001-B1005	Basic Industrial Computer Systems	5
B1101-B1104	Introduction to Microprocessors	4
	Sub-Total	23
	TOTAL	44

PLANT EQUIPMENT STUDY OUTLINE

ELECTRONICS MECHANIC TRAINEE IIIA

I. Basic Television Systems, Closed Circuit (CCTV)

II. Alarm Systems

- A. Intrusion
- B. System Failure

III. Telephone Systems

- A. PBX
- B. Outside Lines
- C. Code Call

IV. Preventative Maintenance

V. Troubleshooting

VI. Specialized Test Equipment - Includes Safety

PLANT EQUIPMENT STUDY OUTLINE

ELECTRONICS MECHANIC TRAINEE IIIB

I. Hydrological, Meteorological, and Water Quality Systems

II. Carrier Current Equipment

III. Digital Techniques

IV. Digital Test Equipment (Specialized) - Includes Safety

V. Supervisory Controls

CORRESPONDENCE COURSES

ELECTRONICS MECHANIC TRAINEE IVA AND IVB

ICS Course No.	Text Titles	Units
	TRAINEE IVA	
B1201-B1208	Microprocessor Applications	8
B1301-B1309	Electronic Instrumentation and Control	9
	Sub-Total	17
	TRAINEE IVB	
B1401-B1405	Industrial Electronic Circuit Applications	5
B1501-B1505	Basic Industrial Electronic System Applications	6
B1601-B1606	Advanced Troubleshooting Techniques	5
	Sub-Total	16
	TOTAL	33

PLANT EQUIPMENT STUDY OUTLINE

ELECTRONICS MECHANIC TRAINEE IVA

I. Advanced Microwave Systems

- A. Radio Units
- B. Antenna and Waveguide Accessories
- C. Multiplex

II. Test Equipment, Microwave - Includes Safety

III. Special Project Assignment

IV. Microprocessors and Microcomputers

V. Testing and Troubleshooting Microprocessors and Microcomputers

VI. Television Surveillance Systems

PLANT EQUIPMENT STUDY OUTLINE

ELECTRONICS MECHANIC TRAINEE IVB

I. Special Project Completion

II. Elementary Programming and PC

III. Antennas and Towers

IV. Supervisory Skills

Upon completion of this phase, the oral examination will include work and study requirements for Phase IV B and all previous work and study areas.

CORRESPONDENCE COURSES

MECHANIC TRAINEE IIA AND IIB

ICS Course No.	Text Titles	Units
	TRAINEE IA	
6718 B	Hydraulic Turbines	1
6634 A-B	Electrical Schematic Diagrams	2
2443	Going Metric	1
5567	Practical Geometry and Trigonometry	1
5004 A	Benchwork - Part 1	1
3500 A	Measuring Instruments	1
2469 C-E	Algebra	3
6687	D. C. Generators and Motors	1
5011	Elements of Chemistry (Reference Only)	1
6238 A-B	Industrial Accident Prevention	2
		Sub-Total 14
	TRAINEE IIB	
1842 A-C	Reading Architect's Blueprints	3
6718 C	Hydraulic Turbines	1
5023	Fundamentals of Grinding	1
6151	Fundamentals of Welding	1
6152 A-B	Practical Metallurgy for Welders	2
3521 A-B	Drilling	2
2246 A-B	Erecting	2
2542	Fasteners	1
6720 A-B	Reading Shop Prints	2
		Sub-Total 15
		TOTAL 29

PLANT EQUIPMENT STUDY OUTLINE

MECHANIC TRAINEE IIA

I. Clearances

- A. Protective Cards
- B. Hold Orders
- C. Placing of Protective Grounds

II. Switching

- A. Switching Order
- B. Precautions When Switching

III. Water Systems

- A. Definitions
- B. Raw Water System
- C. Potable Water System

IV. Direct Current Systems

- A. Description of Systems
- B. Batteries
  - 1. Types
  - 2. Chargers
- C. Emergency Lighting

V. Excitation Systems

- A. Description
- B. Purpose
- C. Operation

VI. Oil Systems

- A. Uses
- B. Systems
- C. Purification
- E. Storage

PLANT EQUIPMENT STUDY OUTLINE

MECHANIC TRAINEE IIB

I. Station Service

- A. Precautions
- B. Description
- C. Operation

II. Power Transformers

- A. Ratings
- B. Purpose
- C. Precautions

III. Governors

- A. Purpose
- B. Type
- C. Operation
  - 1. Oil Pressures
  - 2. PMG
  - 3. Overspeed

IV. Limits, Alarms, and Name Plates

- A. Load Limits
  - 1. Generator
  - 2. Turbine
- B. Temperature Limits
  - 1. Generators
  - 2. Transformers
  - 3. Turbines
- C. Name Plate Data
  - 1. Generators
  - 2. Exciters
  - 3. Transformers
  - 4. Turbines
- D. Annunciation
  - 1. Purpose
  - 2. Description

V. Protective Relays

- A. Description
- B. Purpose
- C. Operation

CORRESPONDENCE COURSES

POWER PLANT MECHANIC, TRAINEE IIIA AND IIIB

ICS Course No.	Text Titles	Units
	TRAINEE IIIA	
6154	Safety in Welding and Cutting	1
6274 A-C	Arc Welding Equipment	3
3536 A-B	Arc Welding Techniques	2
5250	Arc Welding of Alloy Steels and Iron	1
5249 A-B	Arc Welding of Low Carbon Steel	2
5160	Inspection and Testing of Welds	1
2582 A-B	Heat	2
2531 A-B	Lubrication	2
		Sub-Total 14
	TRAINEE IIIB	
2626 A-B	Air Compressors	2
5568 B	Bench Work - Part 2	1
3074 A-B	Roofing	2
4502	Drainage Systems	1
6732	Reading Pipe Prints	1
5602 A-C	Carpentry	3
5887	Properties of Materials	1
6447 A-B	Principles of Heating, Ventilating, and Air Conditioning	2
6084 A-B	Air Conditioning Systems	2
		Sub-Total 15
		TOTAL 29

PLANT EQUIPMENT STUDY OUTLINE

MECHANIC IIIA

I. Safety

- A. Operation of Equipment
  1. Grinder
  2. Lathe
  3. Welder

II. Turbines

A. Type
B. Lubrication
    1. Wicket Gates
    2. Automatic System
C. Operation
    1. Shear Pin
    2. Vacuum Breakers
D. Cavitation
    1. Causes
    2. Methods of Repair
        a. Surface Preparation
        b. Welding Procedures
        c. Grinding Procedures
    3. Safety

III. Bearings

A. Generator
    1. Thrust
    2. Guide
B. Turbine - Guide
C. Lubrication Systems
D. Operation - Temperature Limits

PLANT EQUIPMENT STUDY OUTLINE

MECHANIC IIIB

I. Governor

A. Type
B. Construction
C. Method of Operation
    1. PMG
    2. Compressor
    3. Overspeed Mechanism
    4. Oil System
    5. Pilot Valve
    6. Speed Droop Mechanism

II. Air Conditioning, Heating and Ventilating Equipment

A. Operation and Control
    1. Winter
    2. Summer
B. Maintenance

III. Air Compressors

A. Generator Brake System

B. Station Air System Compressors
   1. Cooling
   2. Lubrication
C. Unloader Valves

CORRESPONDENCE COURSES

POWER PLANT MECHANIC, TRAINEE IVA AND IVB

ICS Course No.	Text Titles	Units
	TRAINEE IVA	
2602	Bearings and Seals	1
2530 A-B	Pumps	2
5389	Tanks and Pumps	1
5581	Pipe-fitting Practices	1
6463	Plumbing and Pipe-fitting Tools	1
5886	Pipes and Fittings	1
6814	Insulation for Pipe Fitting	1
6272	Gas Welding Equipment	1
6276 A-C	Gas Welding Techniques	3
6275 A-B	Gas Cutting	2
5348	Grinding Practice	1
		Sub-Total 15
	TRAINEE IVB	
3520 A-E	Lathes	5
5459 A	Fluid Mechanics	1
2243	Gear Calculations	1
2606	Mechanical Power Transmission	1
6259 A-F	Rigging	6
6235	Inventory Control	1
		Sub-Total 15
		TOTAL 30

PLANT EQUIPMENT STUDY OUTLINE

MECHANIC IVA

I. Clearance Procedures

II. Pumps and Pipe - Fitting in Plant

   A. Types of Pumps
   B. Operating Principles
   C. Pressure Terms

D. Pipe Systems

III. Safety and First Aid

A. Hazards from Painting and Cleaning
B. CO_2 Hazards
C. Emergency Breathing Equipment

IV. Welding

A. Types
B. Methods
C. Safety

PLANT EQUIPMENT STUDY OUTLINE

MECHANIC TRAINEE IVB

Since this is the "topping out" examination, the study questions for IA, IB, IIA, IIB, IIIA, IVB, and IVA are to be included. Selected questions will be added to this examination to determine the understanding and retention by the trainee of all previous training areas.

I. Water Systems

A. Unwatering Systems
B. Generator Cooling System
C. Water Treatment System

II. Sewage Treatment

A. Type
B. Operation
C. Maintenance

III. Supervisory Skills

A. Record Keeping
B. Planning
C. Responsibilities

IV. Machine Shop

A. Components of Shops
B. Safety Precautions

V. Elements of Rigging

A. Splicing, Seizing, and Whipping
B. Precautions
    1. Safe Loads
    2. Stress in Slings
C. Block and Tackle
    1. Advantages
    2. Disadvantages
D. Definitions

VI. Miscellaneous Electrical and Mechanical

CORRESPONDENCE COURSES

OPERATOR TRAINEE IIA AND IIB

ICS Course No.	Text Titles	Units
	TRAINEE IIA	
6718 B	Hydraulic Turbines	1
6589 B	Electric Power Generating Stations	1
6634 A-B	Electrical Schematic Diagrams	
2443	Going Metric	1
5567	Practical Geometry and Trigonometry	1
5004 A	Benchwork - Part 1	1
3500 A	Measuring Instruments	1
2469 C-E	Algebra	3
5011	Elements of Chemistry (Reference Only)	1
2007 A	Solid State Circuits	1
6238 A-B	Industrial Accident Prevention	2
		Sub-Total 15
	TRAINEE IIB	
4030 A-B	D-C Machines	2
6687	D.C. Generators and Motors	1
2007 B-C	Solid State Circuits	1
6718 C	Hydraulic Turbines	1
1842 A-C	Reading Architect's Blueprints	3
4031	Alternators	1
3521 A-B	Drilling	2
2246 A-B	Erecting	2
2542	Fasteners	1
		Sub-Total 15
		TOTAL 30

PLANT EQUIPMENT STUDY OUTLINE

OPERATOR TRAINEE IIA

I. Clearance

- A. Protective Cards
- B. Hold Orders
- C. Placing of Protective Grounds

II. Switching

A. Switching Order
B. Precautions When Switching

III. Water Systems

A. Definitions
B. Raw Water System
C. Potable Water System

IV. Direct Current Systems

A. Description of Systems
B. Batteries
    1. Types
    2. Chargers
C. Emergency Lighting

V. Excitation Systems

A. Description
B. Purpose
C. Operation

PLANT EQUIPMENT STUDY OUTLINE

OPERATOR TRAINEE IIB

I. Station Service

A. Precautions
B. Description
C. Operation

II. Power Transformers

A. Ratings
B. Purpose
C. Precautions

III. Governors

A. Purpose
B. Type
C. Operation
    1. Oil Pressures
    2. PMG
    3. Overspeed

IV. Limits, Alarms, and Name Plates

A. Load Limits
B. Temperature Limits
    1. Generators
    2. Transformers
C. Name Place Data
    1. Generators
    2. Exciters
    3. Transformers
D. Annunciation
    1. Description

V. Protective Relays

A. Description
B. Purpose
C. Operation

CORRESPONDENCE COURSES

OPERATOR TRAINEE IIIA AND IIIB

ICS Course No.	Text Title	Units
	TRAINEE IIIA	
6720 A-B	Reading Shop Prints	1
4018 A	Principles of A-C Circuits	1
4040	Transformers	1
4041	Transformer Operation	1
4042	Distribution and Power Transformers	1
6613	Switchgear	1
4146 A	Electrical Measuring Instruments	1
6698	A-C Motors, Generators, and Rectifiers	1
2582 A-B	Heat	2
2531 A-B	Lubrication	2
6617	Inductance and Capacitance	1
		Sub-Total 14
	TRAINEE IIIB	
6699 A-C	Industrial Motor Control	3
4358	Transmission Lines	1
4032	Alternating Current Motors	1
5887	Properties of Materials	1
5254	Logarithms	1
6732	Reading Pipe Prints	1
2626 A-B	Air Compressors	2
2131 A-B	Digital Methods and Components	2
5019	Fluid Flow	1
6308 A-B	Fluid Flow and Control Instruments	2
		Sub-Total 15
		TOTAL 29

PLANT EQUIPMENT STUDY OUTLINE

OPERATOR IIIA

I. CLEARANCE PROCEDURES

A. Complete Review of Clearance Procedures

II. WATER SYSTEMS

A. Raw Water Uses
B. Unwatering System

C. Treated Water Purification System

III. SELSYN SETS

A. Description
B. Location
C. Operation

IV. DISCONNECT SWITCHES

A. Rating
B. Operation Safety Precautions
C. Maintenance

V. INTERLOCKS

A. Purpose and Types for:
1. Generators
2. Breakers
3. Disconnects
4. Metal Clad Switchgear
5. Control Circuits (Relay, etc.)
6. Governors

VI. ACB's

A. Ratings
B. Operation
C. Maintenance

PLANT EQUIPMENT STUDY OUTLINE

OPERATOR TRAINEE IIIB

I. POWER TRANSFORMERS

A. Description
1. N_2 Blanket
2. Cooling Systems
3. Alarms

II. INSTRUMENTS AND METERING

A. Purpose and Operation
1. Tachometers
2. Voltmeters
3. Synchroscope
4. Oscillograph
5. Clocks

III. FLOWMETERS

A. Type
B. Operation
C. Maintenance

IV. EXCITATION SYSTEM

A. Excitation System Description
   1. Type
   2. Capacity
B. Generator Field Circuit
   1. Field Discharge Resistor
   2. Field Breaker
C. Pilot Exciter (Some Plants)

V. CODE CALL SYSTEM AND ALARMS

A. Review System and Operation

VI. OCB's/GCB's

A. Description
   1. Control Circuit
   2. Operating Mechanism
B. Operation
C. Maintenance
   1. Breaker Time

CORRESPONDENCE COURSES

OPERATOR TRAINEE IVA AND IVB

ICS Course No.	Test Title	Units
	TRAINEE IVA	
4502	Drainage System	1
4305	Lighting Control	1
4343	Storage Batteries	1
4368	Voltage Regulators for Generators	1
6538 A-B	Protective Relaying	2
4048	Telemetering	1
46793	Instrument Transformers	1
4019 A-B	Electric Power Measurements	2
6686	Local Distribution of Electric Power	1
2020	Basic Electronic Components and Schematics	1
2021	Understanding and Using Electronic Diagrams	1
4342	Efficiency Tests	1
		Sub-Total 15
	TRAINEE IVB	
4341	Industrial Motor Application	1
6590 A-B	Electric Power Substations	2
2089 A-H	Electronics in Industry	8
6235 A	Inventory Control	1
6617	Inductance and Capacitance	1
6447 A-B	Principles of HVAC	2
		Sub-Total 15
		TOTAL 30

PLANT EQUIPMENT STUDY OUTLINE

OPERATOR IVA

I. CLEARANCE PROCEDURES AND SAFETY

A. Review of Clearance Procedures and Safety

II. STORAGE BATTERIES AND CHARGES

A. Storage Battery
   1. Type
   2. Safety
   3. Chemical Action
B. Battery Charger
   1. Type
   2. Source of Power
   3. Trace DC Circuit on Drawing

III. GENERATOR VOLTAGE REGULATOR

A. Type
B. Components
C. Operation
D. Control

IV. RELAYS

A. Types
   1. Differential
   2. Overcurrent
   3. Distance Relays
   4. Directional

V. LIGHTING ARRESTERS AND HIGH VOLTAGE FUSES

A. Description
B. Rating

VI. AIR CONDITIONING, HEATING AND VENTILATING EQUIPMENT

A. Description
B. Operation
   1. Winter
   2. Summer
C. Maintenance

VII. GOVERNORS

A. Purpose and Operation
B. Operation
   1. Echelon Control
   2. Permanent Magnet Generator
   3. Fly Ball Motor
   4. Compensation Cable
   5. Shutdown Solenoid
   6. Speed Droop

PLANT EQUIPMENT STUDY OUTLINE

OPERATOR TRAINEE IVB

NOTE: Since this is the "topping out" examination, the study questions for phases 1A, 1B, 2A, 2B, 3A, 3B and 4A are to be included and selected questions will be asked to determine the understanding and retention of all previous training.

I. CARRIER CURRENT

- A. Purpose
- B. Components
- C. Operations
- D. Testing

II. MAIN GENERATOR UNITS

- A. Description
  - 1. Generator
  - 2. Turbine
- B. Operation
  - 1. Starting, Stopping and Loading using a Schematic

III. LOAD, FREQUENCY AND TEMPERATURE RECORDS

- A. Purpose
- B. Operation
  - 1. Generator Field Temperature Recorders
  - 2. Frequency
  - 3. Stator and Transformer Temperature

IV. ANNUNCIATION SYSTEM

- A. Components
  - 1. Relays
  - 2. Trouble Contacts
  - 3. DC Supply
- B. Schematic Diagrams
- C. Maintenance

V. SUPERVISORY SKILLS

- A. Preventative Maintenance Program
- B. Responsibilities Toward Training

VI. TELEMETERING AND REMOTE CONTROL

- A. Purpose

VII. LINE RELAYS AND GROUND DETECTOR SYSTEMS

- A. Line Relays
  - 1. Zones and Protection
- B. Bus Relays
  - 1. Differential
  - 2. Ground
- C. DC Bus
  - 1. Ground Detector

VIII. STATION SERVICE

APPENDIX H

TRAINING ACCOMPLISHMENTS

A trainee, on completion of a 4-year of training program, should have the knowledge and hands-on skills in his/her trade as mentioned below:

H-1. ELECTRICIAN.

a. KNOWLEDGE

(1) Electrical Equipment. Familiar with theory, and working of various components of electrical machinery - windings, commutators, slip rings, wiring, insulation, power control circuits and other associated equipment. Must be capable of understanding electrical schematic diagrams and solid state circuits. Must be familiar with the principles of operation of protective relays, ground detection systems, remote control systems, excitation systems, measuring instruments, rectifiers, control circuits for motor operated disconnects, air circuit breakers, oil circuit breakers, transformers - power, potential & current, excitation systems, lighting arresters and H.V. arresters. Be familiar with National Electrical Code and its application and conformance to all jobs.

(2) Mechanical Equipment. Be familiar with the operating principles of hydraulic turbines, governors, water and oil pumps, lubrication systems, gantry cranes, heating, ventilating and air-conditioning (HVAC) systems, and other auxiliaries such as fishways and spillway machinery.

b. SKILLS

(1) Main Generator. Must be able to assemble/disassemble, repair and maintenance all components of the generator. Be familiar with the capacity, voltage and continuous output rating of the generator. Be able to start and stop the generator and set the reactive power before opening the generator breaker. Know operating and temperature limits of different components of the generator and adjust annunciation systems accordingly.

(2) Voltage Regulator. By using schematic diagram, be able to describe operation of voltage regulator (VR) and adjustments to system voltage. Know source of electric supply to VR, purpose and use of voltage adjusting rheostat and voltage regulator transfer switch.

(3) Exciter. Must know winding arrangements of pilot and main exciters, both rotating and solid state, and methods to control excitation current, purpose of excitation protective relays and how they are connected. Be able to draw a simple diagram showing the excitation system and generator field circuits.

(4) Transformer. Be familiar with all types of transformers (power, potential & current), function of transformers, winding arrangements, cooling arrangements, and control circuits. Be able to draw single line diagram and indicate various components of transformers and the way they are connected.

(5) Circuit Breakers. Be familiar with air and oil circuit breakers, the operating mechanism including arc extinction, D-C control circuits, breaker timer, and ratings.

(6) Protective Relays. Know different types of relays in the power plant, purpose of these relays and their operating and control mechanism, and resetting procedures.

(7) Disconnect Switches. Know operation of manual and motor operated disconnect (MOD) switches. Know the control circuit and key interlocks for MOD switches.

(8) Electrical Measuring Instruments. Must know all electrical measuring and test instruments, what they measure and when and where they are used.

(9) Turbine Governor. Be familiar with the operation of the turbine governor, understand the purpose of the speed sensing device of the governor to include maintenance and repair, and the speed setting of the governor. Be able to adjust limit switches, speed switches, and speed adjust motors.

(10) Air Conditioning, Heating, and ventilating Equipment. Know the working of main air handling unit and temperature control mechanism.

(11) Repair and Maintenance. Must know and recognize components of all electrical equipment in the powerhouse, be able to carry out inspections of all electrical equipment, disassemble and assemble them, repair, test, maintain, and where needed sent them for shop repairs outside the powerhouse. Be able to install rigid conduit, and pull wire and cable as necessary. Be able to record appropriate test data for comparison with future inspections and be able to calculate the rate of deterioration of equipment particularly insulation. Should be able to accomplish tripping tests during periodic inspections and routine maintenance. Be able to maintain and repair all annunciation systems.

(12) Safety and Clearances. Be able to work on all high/low voltage equipment without any harm to self or to others. Understand clearance purpose and procedure, recognize all protective cards, their purpose and use. Be able to clear out all electrical equipment and return them to service.

H-2. ELECTRONICS MECHANIC.

a. KNOWLEDGE

(1) Electronics and Electricity. Must know principles of electronics and electricity - resistors, capacitors, inductors, diodes, transistors, frequency bands, frequency resonance (parallel and series), rectification/inverting, voltage divider, gates, power supplies and charges, oscillator circuit, modulation, microwave transmitters and receivers, microwave channels, public address system, cables (Audio, Fiber Optic, Telephone etc.), basic television systems, radios (AM, FM & SSB), alarm systems (intrusion and system failure), microprocessors and microcomputers; multimeters/meters; relays and oscilloscopes.

(2) Miscellaneous. Be familiar with the working principles of electrical/mechanical equipment in the power plant such as electric generators/motors, pilot and main exciters, hydraulic turbines and governors, safety regulations and safe clearances procedures.

b. SKILLS

(1) Elementary Programming and Personal Computers. Be familiar with the standard software programs used in the power plant system. Be able to access and exit from these software packages. Be able to connect personal computers (PCS) together locally and remotely. Be able to use advanced and diagnostic software, including special applications.

(2) Antennas and Towers. Be able to calculate and check SWR or reflective power on antennas. Be able to establish a base station or a mobile unit with proper type of coax cable and antenna for a simplex/duplex system. Must be familiar with safety precautions to be taken and protective equipment required while working on or around the tower.

(3) Clearance Procedures. Must know who can authorize, issue, hold, and release a clearance. Know the proper use of Hold and Caution cards in the electronic, and lockout procedures. Know the safety requirements when working at a remote location performing routine, preventive, or breakdown maintenance. Know the electronics and electric circuitry in the powerhouse.

(4) Hand Tools. Know the purpose and use of the various air and electric tools and equipment such as soldering and de-soldering equipment, pencils, guns, wicks and suction; chassis punches; drills/taps; rivet tools; board pulling, insertion and cleaning; chip puller; transistors; radio components; cable connectors; wire wrap gun; shirk tubes/heat guns and other tools in the electronic shop. Be able to establish and check grounding for power tools.

(5) Oscillator Circuits. Be able to select and gather material for an oscillator circuit. Be able to build chassis , mount components, connect oscillators and test points for testing input and output.

(6) Test Equipment. Must be able to use multimeters that test more than one electrical quantity and measure values. Be able to connect leads, set switches and controls, and know the safety requirements when using these meters. Be able to use oscilloscope and interpret the screen display relating to voltage, frequency, distortion, and noise. Be able to use other test equipment such as digital storage oscilloscope, digital analyzer, logic probe, pulser, etc.

(7) Radio Installation, Vehicle. Be able to install a radio on a vehicle, know the location of different components to be installed in the vehicle, know the types of antennas used for different types of radios - mobile, portable, base, and repeater; be able to check and set modulation, and adjust frequency.

(8) Microwave Channel. Be able to establish a microwave channel. Know the channel capability of the microwave system, output amplifier, antenna, space diversity, frequency diversity, passive repeaters, base band measurements, type of tuned circuits used in the microwave frequency range, klystron, magnetron, and level settings for a two-wire and a four-wire circuit.

(9) Basic Television Systems, Closed Circuit TV. Know the operation of television surveillance systems, closed circuit TV, cameras and monitors.

(10) Alarm Systems. Be familiar with the various alarm systems mainly intrusion and system failure in the powerhouse. Know what systems have failure alarms, what and where are

the detection devices located that set off a failure alarm. Know the intrusion systems and the locations of detection devices that set off alarms and the actions to be taken when an alarm is actuated.

(11) Supervisory Controls. Must be familiar with the Supervisory Control and Data Acquisition (SCADA) system, communication links, modems, printers, storage devices, synchronous and asynchoronous controllers, microprocessors and microcomputers, software and hardware, assembler and compiler, RAM and ROM; and all event recording systems which are essential for production and control of electric power and flood control.

(12) Testing and Trouble Shooting. Be able to trace trouble points with the help of test equipment and prepare reports, as needed on the faulty equipment.

(13) Maintenance and Repair of Electronic Equipment. Be able to maintains in good working condition all shop and field electronic equipment by timely repair, test and calibration. Maintain maintenance records for individual equipment.

H-3. MECHANIC.

a. KNOWLEDGE

(1) Mechanical Equipment. Know working principles and components of all mechanical machinery and equipment in the powerhouse. It includes hydraulic turbines, governors, cooling systems, air compressors, pumps - water, lubricating; heating, ventilating and air conditioning (HVAC) systems; flood gates, cranes and hoists, machinery in machine shop, acetylene and electric welding equipment.

(2) Electrical Equipment. Know basic principles of electrical machinery, generator - rotor & stator, pilot & main exciters, transformers, circuit breakers, disconnects, and annunciation systems.

b. SKILLS

(1) Hydraulic Turbines. Know and recognize all components of turbines installed in the powerhouse, types of lubricants and the method to lubricate various components such as wicket gates, arms and operating ring. Be able to disassemble, repair, and assemble packing glands. Know location and type of temperature detectors used in the turbine guide, generator guide and generator thrust bearing, their maximum safe operating temperature, cooling systems, and corrective actions if the temperature exceeds those limits. Understand oil flow systems e.g., high lift systems for thrust bearing.

(2) Governors. Know all components of the governor and how they influence operation of the turbine. Know the construction and operation of the generator overspeed mechanism, ratio of speed between flyballs and main shaft, control mechanism of main valve and pilot valve, and opening and closing of wicket gates. Be familiar with the pressure range of the governor, gate limit device, shutdown solenoid, governor oil pumps and method of priming them, speed droop mechanism, function of the compensating mechanism, main relay valve, float operated valve in the governor oil pressure tank, and corrective action to restore a unit to service following a low oil pressure shutdown.

(3) Air Compressors. Be familiar with the working, control, and lubrication of station air compressor and governor air compressor. Know the operating pressure of the generator brake system, be able to jack a unit and return the brakes to normal. Know the tail water depression system, its components and operation.

(4) Heating, ventilating and air conditioning. Be familiar with the air treatment systems, their location in the powerhouse and areas they furnish treated air; working of air conditioning unit and water chilling unit; filtering system used for the ventilating fans; operation and purpose of the heaters used in the generator housing and the generator air cooling system.

(5) Pumps and Pipe-fitting. Know location, purpose, components and operation of all pumps in the powerhouse, use of different types of valves, installation of packing rings, making screwed pipe joints and incidental repair/maintenance work involved with pumps and pipes.

(6) Machine Shop. Know all machinery in the Machine Shop, its operation and use. Be able to accomplish jobs on the lathe, band saw, drill press, milling machine, and other machinery.

(7) Welding. Know the use of acetylene and electric welding equipment, use of flux in welding and purpose of wearing a shield when welding. Be able to repair/weld cavitation damage in addition to other common jobs.

(8) Water Systems. Be familiar with the various water systems used in the power plant, such as raw water system, turbine unwatering system, generator stator cooling system, generator and turbine bearing cooling systems, water purification and sewage treatment systems. Be able to operate and maintain these systems.

(9) Fire Fighting Equipment. Know types of fires and the equipment and chemicals required to extinguish each type. Be aware of precautions to be taken for safety to human life when using fire extinguisher, and procedure for reporting fire alarms in the powerhouse.

(10) Safety and Clearance Procedure. Must be familiar with the safety rules and regulations pertaining to power plants and be able to take adequate precautions while working on different jobs such as welding, grinding, cleaning generator shaft with the unit in motion, working in the wheel pit of a machine, painting or cleaning with paint thinning solutions, and use of breathing equipment. Know the precautions to be taken to avoid contact with the live electric current. Recognize safety hazards of moving equipment; compressed air, gas, and liquids; electric shocks; flying particles, dust, dirt and fumes; and working in contained spaces. Know and recognize all clearance cards and purpose of each card, responsibilities of the person receiving a clearance, and actions for clearing in and clearing out. Understand why it is necessary to follow a switching order in the exact order in which it is written.

(11) Elements of Rigging. Understand and be able to accomplish things like splicing and seizing hemp and wire ropes. Be able to handle and use wire ropes in a safe manner, determine the safe load capacity of a hook, mechanical advantage of block and tackle in handling heavy loads, use of shackles and rope clips and their applications. Should be able to define and use choker, double-bridge slings, thimble, open and closed sockets, and spelter sockets.

(12) Maintenance and Repair of Mechanical Equipment. Be able to maintain, repair, adjust, and lubricate mechanical features of generators and motors, turbines and pumps,

governors, overhead or gantry cranes, high pressure CO2 systems, HVAC systems, elevators, sluices and spillway gate hoists with cables or chains, machine shop tools, water treatment and waste disposal plants, oil storage and purification systems, automatic and manual fire extinguishing equipment; mechanical, pneumatic and hydraulic controls, and other mechanical features of the power project. Must be able to diagnose mechanical failures of equipment and perform repairs as needed on all mechanical operating equipment of the powerhouse, dam, and intake structures. Be able to test repaired equipment to assure proper performance.

H-4. OPERATOR.

a. KNOWLEDGE

(1) Electrical Equipment. Be familiar with the working principles of AC and DC motors and generators, exciters, voltage regulators, circuit breakers, transformers, switches, and relays.

(2) Mechanical Equipment. Be familiar with the working principles of water turbines, governors, water and air pumps, lubrication systems, heating and cooling systems. Be familiar with the structural and mechanical features of dam, intake structures, and spillways.

b. SKILLS

(1) Hydropower Unit. Able to start and connect a unit to the power system, know setting of reactive power and actions to be taken to control runaway speed of the unit. Be able to coordinate operation of power plant and dam to satisfy flood control, stream flow, power contract commitments, and other requirements. Be able to take appropriate actions to restore power after interruptions, remove faulty equipment from service, and provide computer input and update of all data associated with the operation of the generating units.

(2) Generator. Know and recognize all components of the generator, its rating and operating and maximum temperature limits.

(3) Exciter. Be able to control and monitor pilot and main exciters.

(4) Voltage Regulator. Know components and working of various kinds of voltage regulators and be able to control voltage through the use of voltage rheostat.

(5) Transformers. Know and recognize all types of transformers - power, potential and current. Recognize alarms on transformers, what causes them and actions to be taken on receiving the alarms.

(6) Circuit Breakers. Understand control circuits, and be able to operate all circuit breakers - oil & air, by remote or manual control.

(7) Relays. Know all relays used in power plant, reasons for relay trips and how to reset them.

(8) Disconnect Switches. Be able to operate all switches - motor operated or manual, without harm to self or others.

(9) Turbines. Be familiar with different types of turbines, and be able to operate servo motors, wicket gates, and other auxiliaries.

(10) Governors. Be familiar with various components of the governor - actuator, pumps, permanent magnet generator, and corrective actions on low generator oil pressures.

(11) Interlocks. Be able to accomplish electrical and mechanical interlocks pertaining to generators, circuit breakers, disconnect switches, metal clad switchgear, relays and governors.

(12) Instruments and metering. Know purpose and use of all meters and be able to read them correctly.

(13) Annunciation Systems. Know types and main features of all annunciation systems and actions to be taken on receiving an annunciation. Know what each alarm means and where the individual alarm reading units are. Be able to recognize degree of urgency to each alarm and allocate resources and attention accordingly.

(14) Clearance Procedure. Be able to issue clearances both electrical and mechanical on all major equipment under the "Safety Clearance Procedure" ER 385-1-31. Know the purpose and use of protective card - when and where, and procedure for clearing out. Be able to use electrical and mechanical drawings in the performance of switching and operating procedures.

(15) Water Systems. Know all water systems in the power plant - raw water, potable water, unit unwatering system, generator stator coils and bearing cooling water systems.

(16) Storage Batteries and Charges. Know type of storage batteries and charges in the powerhouse, D-C circuits and how batteries are connected to the D-C bus.

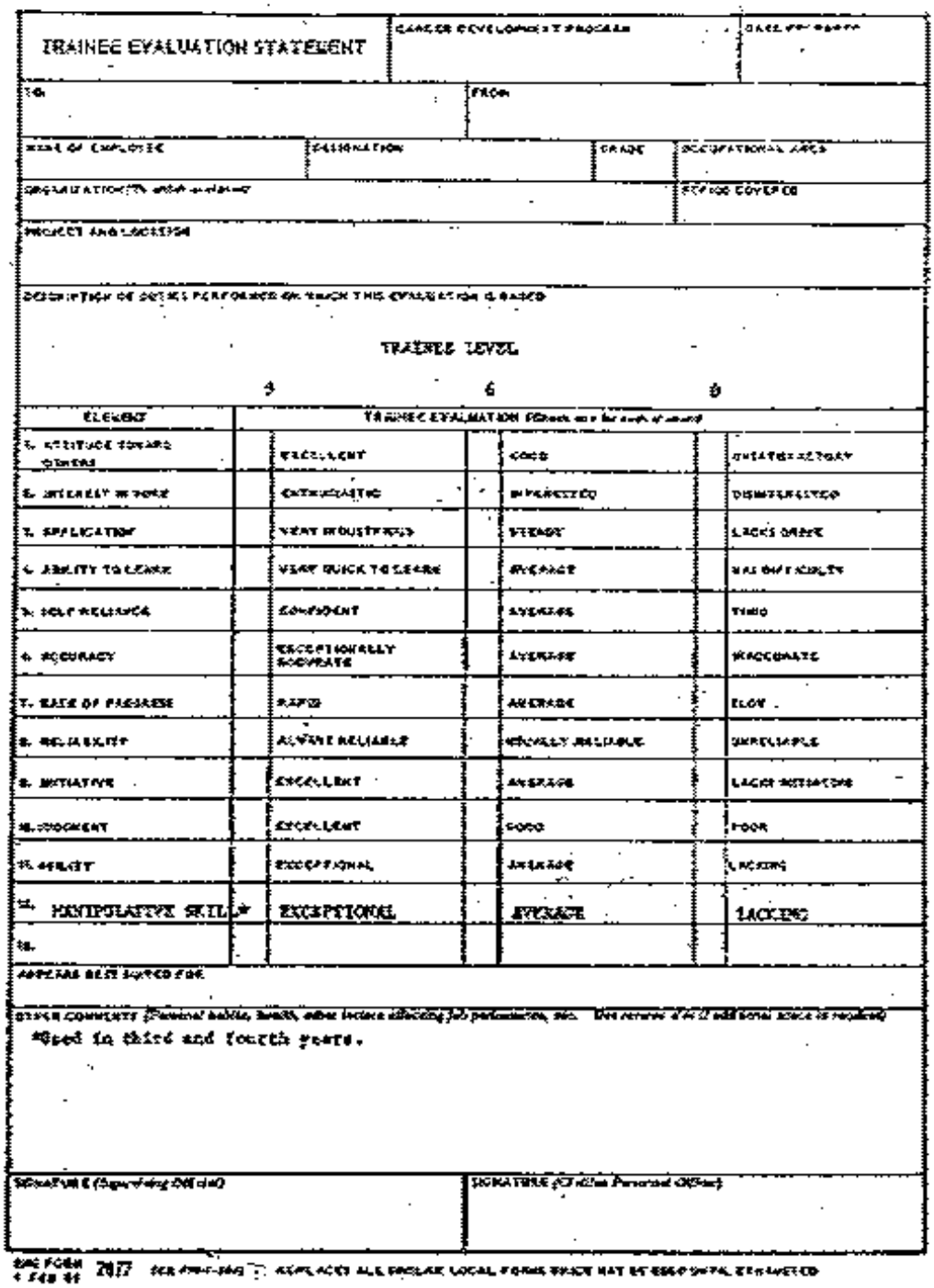
(17) Heating and Ventilating Systems. Know how to operate heating and ventilating systems and control the temperature.

(18) Station Service. Know both AC and DC systems for normal and emergency source of power, and operation and utilization of emergency power.

(19) Record Keeping. Be able to prepare records such as daily log of important events, periodic summaries of water control operations, pool and tailwater elevations, energy and capacity deliveries, weather, equipment failures, outage and operating time. Be able to calculate from tables and meters the water inflow, water discharge through turbines and gates, and reservoir volume.

APPENDIX I

TRAINING RECORDS



TRAINEE EVALUATION STATEMENT

CAREER DEVELOPMENT PROGRAM

DATE OF REPORT

TO

FROM

NAME OF EMPLOYEE | DESIGNATION | GRADE | OCCUPATIONAL AREA

ORGANIZATION (Name and address)

PERIOD COVERED

PROJECT AND LOCATION

DESCRIPTION OF DUTIES PERFORMED ON WHICH THIS EVALUATION IS BASED

TRAINEE LEVEL

5 6 8

ELEMENT	TRAINEE EVALUATION (Check one for each element)			
1. APTITUDE TOWARD WORK	EXCELLENT	GOOD	SATISFACTORY	
2. INTEREST IN WORK	OUTSTANDING	IMPROVED	DISINTERESTED	
3. APPLICATION	VERY INDUSTRIOUS	STEADY	LACKS DRIVE	
4. ABILITY TO LEARN	VERY QUICK TO LEARN	AVERAGE	HAS DIFFICULTY	
5. SELF RELIANCE	CONFIDENT	AVERAGE	TIMID	
6. ACCURACY	EXCEPTIONALLY ACCURATE	AVERAGE	INACCURATE	
7. RATE OF PROGRESS	RAPID	AVERAGE	SLOW	
8. RELIABILITY	ALWAYS RELIABLE	USUALLY RELIABLE	UNRELIABLE	
9. INITIATIVE	EXCELLENT	AVERAGE	LACKS INITIATIVE	
10. JUDGMENT	EXCELLENT	GOOD	POOR	
11. AGILITY	EXCEPTIONAL	AVERAGE	LACKING	
12. MANIPULATIVE SKILL	EXCEPTIONAL	AVERAGE	LACKING	
13.				

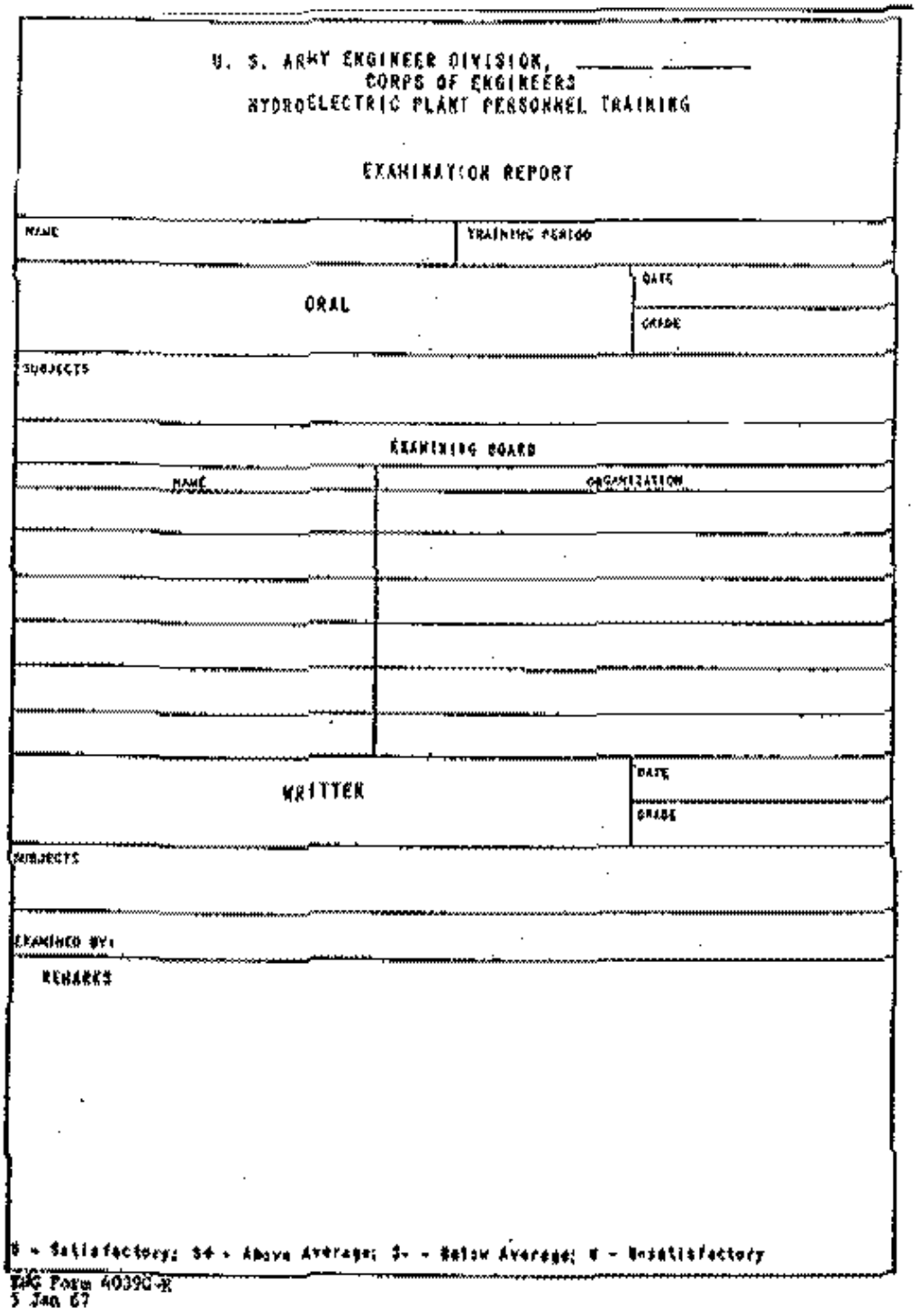
APPEARS BEST SUITED FOR

OTHER COMMENTS (Personal habits, health, other factors affecting job performance, etc. Use reverse side if additional space is required)

*Used in third and fourth years.

SIGNATURE (Supervising Official) | SIGNATURE (Civilian Personnel Officer)

DAC FORM 2077 (SEE PAMPHLET) REPLACES ALL PREVIOUS LOCAL FORMS WHICH MAY BE USED UNTIL EXHAUSTED



U. S. ARMY ENGINEER DIVISION, _____
CORPS OF ENGINEERS
HYDROELECTRIC PLANT PERSONNEL TRAINING

EXAMINATION REPORT

NAME | TRAINING PERIOD

ORAL | DATE | GRADE

SUBJECTS

EXAMINING BOARD

NAME	ORGANIZATION

WRITTEN | DATE | GRADE

SUBJECTS

EXAMINED BY:

REMARKS

S - Satisfactory; SA - Above Average; S- - Below Average; U - Unsatisfactory

ENG Form 4039C-R
5 Jan 67

TRAINING AND DEVELOPMENT PROGRAM
FOR HYDROELECTRIC POWER PLANT PERSONNEL
PART _____*
POWER PLANT _____**

EXAMINATION SCORE SHEET

Date _____

Name _____ Plant _____

No.	Possible Points	Raw Points	No.	Possible Points	Raw Points
1.			14.		
2.			15.		
3.			16.		
4.			17.		
5.			18.		
6.			19.		
7.			20.		
8.			21.		
9.			22.		
10.			23.		
11.			24.		
12.			25.		
13.			26.		
			TOTALS		

Length of Examination _____ Hours _____ Minutes

SIGNED:

1. _____

2. _____

3. _____

MEMBERS OF THE EXAMINING BOARD

*(Part II-B, etc.)
**(Trainee; Electrician Trainee; etc.)

ENG Form 4039B-R
5 Jan.67

_____
(Trainee's Name)

PHASE OF TRAINING _____

FINAL GRADE _____

LOCATION _____

IOS POINTS	_____
EXAMINATION POINTS	_____
TRAINEE EVAL. POINTS	_____
TOTAL RAW POINTS	_____
MAXIMUM POSSIBLE POINTS	_____
COMPUTED SCORE	_____
(DOL REQUIRED FOR EXAMINATION	_____

COMMENTS:

SIGNATURES, EXAMINING COMMITTEE DATE _____

_____

_____

_____

ENG Form 4079-R
5 Jan 67

BI-WEEKLY TRAINING PROGRAM

Name _____ Electrical ___ Mechanical ___ Operator ___
Location _____ Period _____

Training Item	Week ending _____ Sun	Mon	Tue	Wed	Thu	Fri	Sat	Total Hours	Week ending _____ Sun	Mon	Tue	Wed	Thu	Fri	Sat	Total Hours
I																
II																
III																
IV																
V																
VI																
VII																
VIII																
IX																
X																
XI																
XII																
Classes-Study																
	Hours each week															

Annual Leave ___
Sick Leave ___

(List study assignments & Courses on reverse side)

Total Training Hours

Trainee _____ Training Representative _____ Power Project Superintendent _____

ENG Form 4039E-R
5 Jan 67

I. POWER PLANT PERSONNEL REQUIREMENTS	Operator	Electrician	Mechanic
A. Total number of positions now authorized.			
B. Total number of positions in 2 years.			
C. Number of foreman or senior positions now authorized.			
D. Number of foreman or senior positions in 2 years			
E. Number of foreman or seniors 50 or older in 2 years			
F. Number of journeyman positions now authorized			
G. Number of journeyman positions in 2 years			
H. Number of journeyman 50 or older in 2 years			
I. Number of trainees now assigned to job classification			
J. Ratio of (E) above to (D) above.			
K. Ratio of (H) above to (G) above.			
L. Special Considerations:			
1. _____			
2. _____			
3. _____			
4. _____			

Priority Assigned: _____

REASONS: _____

_____

_____

_____

ENG Form 4039F-R
5 Jan 67

II. TRAINEE - OVERALL EVALUATION

A. Trainee's Record.

1. Technical Training.

a. Strengths:

b. Weaknesses:

2. Practical Training.

a. Strengths:

b. Weaknesses:

3. Productive Work.

a. Strengths:

b. Weaknesses:

B. Superintendent's Rating of Trainee by occupational aptitude:

1. _____;

2. _____;

3. _____.

III. TRAINEE'S CHOICE: _____

IV. ASSIGNMENT: _____

REASONS: _____

_____

_____

_____

_____

_____

1. _____

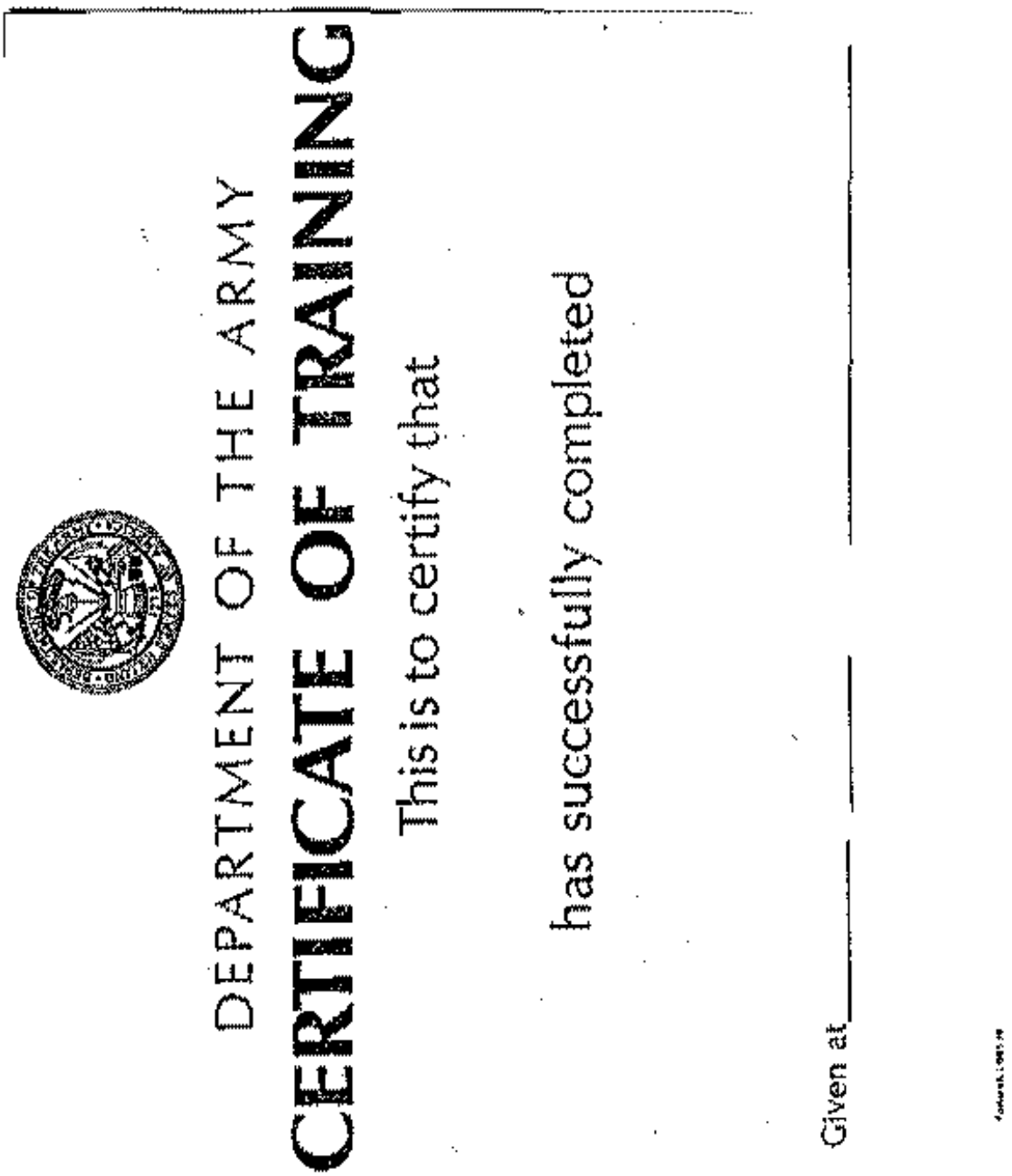
2. _____

3. _____ _____

SIGNATURES OF EXAMINING COMMITTEE DATE

APPENDIX J

CERTIFICATE OF TRAINING (DA FORM 87)



DEPARTMENT OF THE ARMY

CERTIFICATE OF TRAINING

This is to certify that

has successfully completed

Given at _____ _____

APPENDIX K

BACKGROUND INFORMATION

K-1. Generator:

(a) Manufacturer

(b) Date placed in commercial service

(c) Type and age of present winding insulation

(d) Rating (MVA and power factor):

(I) Nameplate
ii) Overload capacity

(e) Shaft data:

I) Inside diameter
(ii) Outside diameter
(iii) Material
(iv) Forged or fabricated
(v) Stress

(f) Impedance

(g) Field current at rated load

(h) Flywheel effect (WR^2)

K-2. Turbine:

(a) Type

(b) Rating (HP and head)

(c) Shaft data:

(I) Inside diameter
(ii) Outside diameter
(iii) Material
(iv) Stress

(d) Cavitation limitations

(e) Flywheel effect (WR^2)

K-3. Transformer:

(a) Manufacturer

(b) Class (OA/FOA, FOA, FOW)

(c) Rating (MVA, voltage, impedance)

(d) Number of connected units

K-4. Excitation Equipment:

(a) Manufacturer

(b) Type:

(I) Rotating
(ii) Static

(c) Nominal voltage rating

(d) Continuous current rating

K-5. Governor

(a) Manufacturer

(b) Rating, lbs. - ft.

(c) Type (Electronic or mechanical)

K-6. Generator Circuit Breaker:

(a) Manufacturer

(b) Type

(c) Rated maximum voltage

(d) Rated continuous current

(e) Rated short circuit current and interrupting capacity

K-7. Buses:

(a) Manufacturer

(b) Type

(c) Rated maximum voltage

(d) Rated continuous current

(e) Rated momentary current

K-8. Penstocks, Water Passages and Other Considerations:

APPENDIX L

EVALUATION ITEMS

L-1. Units in plant:

(a) Total number

(b) Number of units with similar windings

L-2. Operating conditions:

(a) Overload

(b) Temperature

(c) Peaking, base loaded, condensing, or other

(d) Starts per month (other cycling modes)

(e) Age

(f) Hours of operation

L-3. Winding conditions:

(a) Visual inspection results

(b) Stator electrical tests (significant tests supporting the recommended course of action)

L-4. History:

(a) Non-routine maintenance performed

(b) Failures and resolution

L-5. Experience with similar windings

L-6. Confidence in original installation

L-7. Economic justification: (See Appendix C)

L-8. Letter of Support and/or Marketability for PMA

L-9. Potential Environmental Issues

APPENDIX M

ECONOMIC ANALYSIS GUIDANCE

It is not intended that a Major Rehabilitation Evaluation Report be prepared for each rewind project. The level of detail should be commensurate with the complexity of the project. The analysis should draw on the basic framework outlined in the current "Guidance for Major Rehabilitation Projects."

M-1. General. Economic evaluations for rewind letter reports should be conducted in accordance with the analytic requirements for Major Rehabilitation Evaluation Reports (see ER 1130-2-500, Chapter 3). This methodology combines estimated equipment reliability, the probability of unsatisfactory performance (failure), and the physical and economic consequences of failure, in computing the life cycle costs of the alternatives being considered. While major rehabilitation proposals may be expensive and require significant analysis to support a recommendation, generator rewinds are limited in scope and cost. Therefore, the analysis to support rewind recommendations, should be limited.

M-2. Requirements. For a forced rewind (see Chapter 6 of ER 1130-2-510, Hydroelectric Power Operations and Maintenance Policies), the letter of support from the Power Marketing Agency, is sufficient justification for the proposed action and an economic analysis is not needed. For all other rewind proposals, the economic rewind study requirements are listed below.

a. Development of the Base Condition. The base condition is the alternative to which all other plans will be measured against. The following items should be considered in the development of the base condition.

(1) Assume that the project will be operated in the most efficient manner possible in the absence of the proposed rewind. If the project benefit stream is interrupted due to unsatisfactory feature (generator) performance, assume that funds will be made available to fix the feature.

(2) The timing, frequency and physical consequences of system disruptions are all unknown and must be estimated. The costs and durations of prior failures is important and useful information in estimating economic consequences and in establishing a pattern of failures. This information should be available from the Hydroelectric Design Center and District Operations personnel.

(3) Assumptions should be reasonable and clearly stated. Rely on available data where possible.

(4) The potential for minor failures (a repairable outage of short duration) should be considered in addition to failures that require a full generator rewind.

(5) The units use and availability must be considered relative to other units at the specific project. Plant factors and operational characteristics (peaking versus base load) will impact the economic value of replacement.

b. Alternatives. Only a limited number of alternatives need to be addressed for rewind letter reports. Alternatives (3) and (4) have very limited application.

(1) Rewind In-Kind. This alternative consists of a scheduled acquisition and installation of a new generator winding.

(2) Rewind with Uprate. For reports where uprating of the winding is being considered (i.e. a non-incidental increase in the nameplate capacity) the analysis must demonstrate that the additional benefits of the uprate exceed the additional costs (incremental justification).

(3) Purchase Spare winding. In this alternative, a spare winding is acquired. Installation of the winding occurs only when the unit fails and can no longer be repaired. This alternative limits expenditures in the budget year, and minimizes unit outage time when failure occurs, and unit rewind is required.

(4) Combinations. If more than one unit at a plant is being considered for rewind, combinations of rewinds and spares should be evaluated.

{5) Exclusions. While the following alternatives are considered in Major Rehabilitation Reports, they do not need to be evaluated for rewind letter reports.

(a) Increased Maintenance. In most cases, increased or more frequent maintenance of generator windings will not extend the useful life and need not be considered as an alternative.

(b) Optimal Timing for Implementation. Optimization of implementation timing does not need to be addressed; only the budget year(s) under consideration need to be evaluated.

c. NED Values. Lost hydropower production due to Scheduled and unscheduled outages should be evaluated using NED-based economic losses (not revenues). Lost energy production, should, therefore, be evaluated as the avoided cost of generation using a system production cost model such as PWRSYM or PC-SAM. The report should explain how such losses have been estimated and the methodology and model(s) employed to determine NED-based unit values of energy and capacity.

M-3. Short Cuts/Expedited Processes. The purpose of the economic analysis is to assist in providing sufficient justification to support a rewind action. If recent reports and analyses have been completed for the specific project which would support the recommended rewind action, then these findings may be summarized in lieu of conducting a new economic analysis. Assumptions and calculations must be clearly described and the hydropower values cited must no more than 3 Fiscal Years old from the date of the proposed rewind report submission. For example, if a prior report used hydropower values that were developed at October 1992 price levels (FY 1993), then they would be acceptable for a rewind report being submitted during FY 1996. If the values were developed before FY 1993, then they could not be used for a FY 1996 rewind report submission.

M-4. Analytic Tools and Technical Assistance. Several economic models, consistent with major rehabilitation evaluation criteria, have been developed for rewind studies. Technical assistance in conducting the economic analysis or in utilizing an existing model may be obtained through CENPD-HDC or CECW-IWR-T.

APPENDIX N

ADDITIONAL TECHNICAL REFERENCES

These technical references are not intended to be exclusive and test methods from other sources accepted by the industry may be used.

1. Doble Rotating Machinery Insulation Test Guide
2. IEEE Standard 4 - Techniques for High Voltage Testing
3. IEEE Standard 43 - Recommended Practice for Testing Insulation Resistance of Rotating Machinery
4. IEEE Standard 56 - Insulation Maintenance of Large AC Rotating Machinery (10,000 KVA and Larger)
5. IEEE Standard 62 - Guide for Field Testing Power Apparatus Insulation
6. IEEE Standard 67 - Guide for Operation and Maintenance of Turbine Generators
7. IEEE Standard 95 - Insulation Testing of Large AC Rotating Machinery with High Direct Voltage
8. IEEE Standard 112 - Test Procedure for Polyphase Induction Motors and Generators
9. IEEE Standard 115 - Test Procedure for Synchronous Machines
10. IEEE Standard 117 - Test Procedure for Evaluation of Systems of Insulating Materials for Random-Wound Electric Machinery
11. IEEE Standard 118 - Test Code for Resistance Measurements
12. IEEE Standard 119 - Recommended Practice for General Principles of Temperature Measurements as Applied to Electrical Apparatus
13. IEEE Standard 120 - Master Test Code for Electrical Measurements in Power Circuits
14. IEEE Standard 275 - Recommended Practice for Thermal Evaluation of Insulation Systems for AC Electric Machinery Employing Form-Wound Pre-Insulate Stator Coils, Machines Rated 6900 Volts and Below
15. IEEE Standard 286 - Recommended Practice for Measurement of Power-Factor Tip-Up of Rotating Machinery Stator Coil Insulation
16. IEEE Standard 433 - Recommended Practice for Insulation Testing of Large AC Rotating Machinery with High Voltage at Very Low Frequency

17. IEEE Standard 434 - Guide for Functional Evaluation of Insulation Systems for Large High-Voltage Machines

18. IEEE Standard 454 - Recommended Practice for the Detection and Measurement of Partial Discharges (Corona) During Dielectric Tests

19. IEEE Standard 492 - Guide for Operation and Maintenance of Hydro-Generators

20. IEEE Standard 522 - Guide for Testing Turn-to-Turn Insulation on Form-Wound Stator Coils for AC Rotating Electric Machines

For a free catalog of IEEE Standards, write to the:

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